The Foundry Trade Journal

AND

PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. 10. JULY, 1908. No. 79.

—PUBLISHED—
THE FIRST WEEK IN EACH MONTH BY

EAGLAND & Co., Ltd.
165, STRAND, LONDON, W.C.

Subscription Terms: 7s. 6d. per annum, post free.
To place the "Journal" within the reach of Working Moulders and Pattern-makers the Proprietors will accept subscriptions, not less than three in number from one shop, at the reduced rate of 5/- per annum, such order to be countersigned by the superintendent or foreman.

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THE FOUNDRY TRADE JOURNAL,
165, Strand, London, W.C.

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NOTES AND COMMENTS.

The Institute of Metals.

THE formation of this Institute is only in keeping with the trend of modern progress, and may be taken as another indication of the steady march of scientific research, which is influencing for good all our trades. No longer is the duty of experiment and enquiry relegated to a few enthusiasts, but the workers as a whole, are alive to the fact that they have in their hands the power to raise the status of their callings and help on the cause of advancement. The history of technical societies is an interesting one, showing as it does the different stages of evolution and reproduction which have lead up to the present-day institutions. The new-born institute (a very promising offspring of the older ones) is a striking example of the progress and development that is taking place, for hitherto the work for which it has been created has been regarded as more or less embraced by existing institutions. The increasing demands for knowledge and research, however, have insisted on greater specialisation. Two hundred years ago the Royal Society was able to deal with scientific problems of every nature, and satisfy practically all the demands the worker made at the time, but as its value became better appreciated, there grew many branches from the parent body. These, in turn, have been forced to divide their duties with others in order to keep pace with the times. The Institute of Civil Engineers, for some time sufficed for the needs of the engineer, but inevitably there came the establishment of the Institute of Mechanical Engineers; and in a similar manner other branches of work have formed institutions to cater for their special needs. Any doubt as to the service rendered by these younger institutions may be dispelled by a brief review of the work done by the foundry trade associations.

The possibility of trade secrets hampering the success of a technical institution must not be taken too seriously. As Sir W. White remarked, there is room enough for valuable work without touch-

ing on disputable points that are likely to prejudice the interest of individual members. In the case of the Iron and Steel Institute the same objection as to trade secrets was raised, but eventually proved groundless. The day has almost gone when commercial success depended on the secrecy with which certain operations were carried on. There are still, of course, some businesses which owe their success to this, but in the majority of cases the advantages derived from intercourse with fellow workers, and the expansion of general knowledge in connection with the work, outweigh the other considerations. This has been the experience of our most prominent workers, as testified by the support given to the new institute.

The Sampling of Pig-iron.

Optimistic foundrymen are looking forward to the time when the purchase of pig-iron by analysis will be the rule rather than, as now, the exception. Inseparably associated with this ideal is the question of a standard method of analysis; for in the absence of a definite method of obtaining representative analyses, any attempt to purchase on the desired basis would be simply farcical. The question of obtaining a representative sample of a bulk of pig-iron is a vexed one to many founders, and the trouble is too often aggravated by the selection of the samples being left to one who does not understand the importance of representative selection. But even when representative samples of the iron are obtained, the methods of drilling the pigs for the chemist vary according to the fancy of the individual. To anyone with the most casual knowledge of the composition of different parts of a pig it will be obvious that this can only result in irregularities; and whatever the respective merits of the different methods may be, the variance in the results obtained is sufficient proof that not all are accurate. It is quite time that a standard method of sampling and analysis were adopted, both in the interests of the maker and the foundryman. At present the ironmaker proceeds on his own way and obtains his result; the foundryman, probably with a very indifferent knowledge on the matter, also follows his own course, with the result that the two analyses not only often disagree, but both may be incorrect and not representative of the metal as a bulk. It is for the user and the maker of pig-iron to decide on the most suitable method and then adopt it as a standard. A movement to this end would not be premature, and would, we venture to think, be welcomed by all parties concerned.

It is interesting to note that the American foundrymen, at their annual Convention last month, passed a motion favouring the abolition of grading pig-iron by numbers and the substitution of chemical analysis.

BRASS CASTING REGULATIONS.

In June of last year the Home Office issued draft regulations proposed to be made for factories in which the process of casting brass is carried on. Mr. W. Wills, who was appointed to hold an inquiry, now reports that he entertains no doubt that the process of brass casting, as it is carried on at present in the majority of cases, is properly classed as a dangerous trade; but there appears to be a considerable divergence of opinion among those engaged in the trade as to the character and extent of the mischief. In regard to ventilation, strong opposition was made on the part of the employers to their being compelled to install the exhaust draught "at, or as near as possible to the point of origin" of the fumes. It was urged that the only known apparatus which fulfilled this condition was Lyne & Rainsford's invention, and evidence was given that this invention, which has been found to work successfully in the case of "sand-casting" (though not in all cases), is unsuitable for "strip-casting" and "solid-drawn tube-casting." He has no hesitation in suggesting that regulations should be modified so as to specifically refer to other forms of apparatus for securing an exhaust draught.

In regard to the objection that there were many casting shops where the air space was so large that there was no practical danger, he recommends the exemption of sand-casting shops having an air space equivalent to 2,500 cubic feet for each of the persons employed, and the exemption of other shops having an air space equivalent to 3,500 cubic feet for each of the persons employed. In addition to this automatic exemption, he thinks it will be necessary to provide also for individual exemption in exceptional circumstances, to be granted at the discretion of the chief inspector. As to lavatory requirements, he is disposed to recommend the enactment of the regulation wherever exhaust draught is also required. He thinks the period of 18 months from the date of the enactment of the regulations will not be an excessive time allowance.

BRITISH FOUNDRYMEN'S ASSOCIATION.

The Testing of Alloys.

By W. B. Parker, F.T.C.

A meeting of the Birmingham Branch was held in the Technical School, Birmingham, on Saturday, May 23, Mr. R. Buchanan presiding. Members of the Birmingham Metallurgical Society attended, in response to an invitation, as a return compliment for a similar invitation recently offered to the Foundrymen by the Metallurgists on the occasion of Mr. Thomas's paper. The subject on this occasion was a paper by Mr. W. B. Parker, F.I.C., who holds an important position at the large establishment of the British Thomson-Houston Company, of Rugby, on the subject of "The Testing of Alloys." The paper, which is given herewith, was illustrated by various diagrams, with a number of samples of alloys.

Everyone will agree, that to be of value, testing must be honestly, thoroughly, and intelligently performed. During the last six years the author has had occasion to visit a large number of works' testing laboratories, and regrets to say that these visits tend to show the staffs frequently lack accurate and proper training for their duties, and often can only perform a limited number of crude routine tests. This state of affairs is not entirely the outcome of employers begrudging the expense of properly qualified operators, and the necessary instruments. In some cases it is due to a fear that certain "so-called" secret processes or mixtures, which form the manufacturer's stock-in-trade, would not long survive the advent of honest and intelligent scrutineers.

Such firms stand in their own light, because an imperfectly trained laboratory staff is of very limited value. It may, and often does, constitute a source of monetary loss.

Modern Testing.

Modern testing machines date from 1861, in which year David Kirkaldy (the founder of the now famous testing laboratories of Messrs. David Kirkaldy & Son, Southwark, London), invented and designed the first hydraulic testing machine. It is a 450-ton horizontal, multi-lever machine, fitted for testing very long specimens. A full description of it will be found in W. G. Kirkaldy's book, "Strength and Properties of Materials."

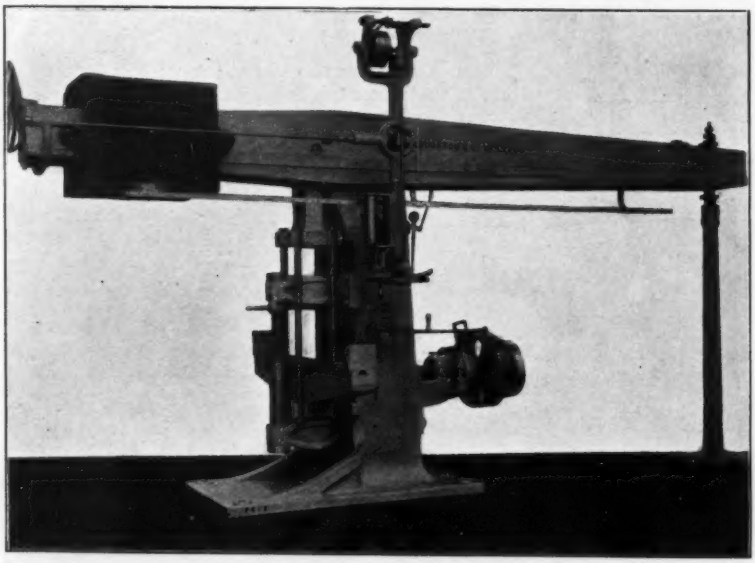


Fig. 1.—50-ton Buckton Testing Machine.

Tensile testing machines are divisible into two chief types:—(1) Single-lever machines; (2) multi-lever machines.

The 50-ton vertical, single-lever Buckton machine used in the laboratory of the British Thomson-Houston Company, Limited, Rugby, is a good example of the first type (see Fig. 1). It is fitted to perform tension, compression, transverse, hardness, and shearing tests. For testing large area specimens the motive power employed is a direct-current electrical motor. For small area specimens the stress is applied through the same gearing by means of a hand-wheel (not shown in the illustration). For machines up to 100 tons capacity the vertical single-lever type is preferable, and for these sizes the best motive power is probably an electrical motor working through suitable gearing. This purely mechanical machine has the advantage over the hydraulic machines that the stress can be maintained constant upon the specimen for any length of time, and, therefore, the gradual stretch of materials under constant loads can be estimated. Such tests are now of considerable importance to designing engineers.

The second group of machines is subdivisible into Class A, vertical multi-lever machines, and Class B, horizontal multi-lever machines. Messrs. W. & T. Avery's machine is an example of Class A, while Messrs. Buckton & Company's 100-ton horizontal machine (Fig. 2) illustrates Class B. The horizontal multi-lever type is the best for machines of over 100 tons capacity.

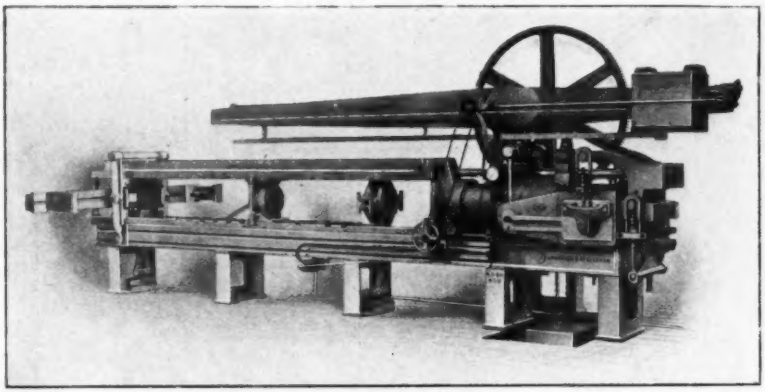


FIG. 2.—100-TON HORIZONTAL TESTING MACHINE.

Speeds of Pulling and Loading.

For testing alloys and pure metals it is essential that the pulling speed shall be under nice control. For a 50-ton machine the maximum working speed of the pulling head should not exceed 1 in. per minute. The minimum should be ¼ in. per minute. The return or non-working speed of the pulling head should be fully 3 in. per minute, otherwise the work goes too slowly. The speed of the poise weight for loading (when worked by mechanical means) should also be variable and capable of control.

For a 50-ton machine, the author thinks the maximum rate of the traverse of the poise, when loading, should not exceed half a ton per second; in fact, this is usually too fast.

The measuring scale and vernier should be graduated in both "pounds" and "tons" (avoir.), because it saves considerable time in reporting.

Sampling.

Sampling is a subject which creates much difference of opinion. To sample wrought alloys, such as drawn, rolled, and squirted bars, rods and narrow strips, it is merely necessary to cut off (cold) a sufficient length.

The author has standardised the following lengths for use at the works of the British Thomson-Houston Company, Limited, Rugby:—

TABLE I.

Relation of Length and Diameters of Samples.

Dimensions of Stock. Rounds, Square, Hexagon, &c			Length of Sample. Minimum requirements.
	Inches.	Inches.	Inches.
From and including	1.50	and over	15
,, ,,	1.25	to 1.49	12
,, ,,	0.875	to 1.25	10
,, ,,	0.625	to 0.874	8
,, ,,	0.400	to 0.624	7

The 12 in. and 15 in. lengths permit two short test pieces being turned out of them, or one long test piece. Preference is usually given to one long test piece because the accuracy attainable on this is greater than on the shorter ones.

In the case of hexagons, the diameter of the inscribed circle gives the dimension to be worked from when taking samples, and in the case of flats (rectangles), the smallest cross-sectional dimensions; thus, a bar 1 in. by ½ in. cross-section allows a ½ in. diameter grip end test piece, therefore the sample piece must be 7 in. long.

Thin sheets and wide thin strips are best sampled by punching out a strip 3½ in. wide by 15 in. long in a press. The crude method of cutting out the strip by means of a chisel should be avoided; it damages the samples.

Sheets over ¼ in. in thickness are sampled by "shearing" the strip off. In the case of very thick sheets and slabs, either saw, plane or slot it off.

Cast, forged, or rolled rings, hoops or sleeves are best sampled by "parting off" a portion of the ring, sawing this into convenient lengths and turning the test pieces out of these. They must neither be hot nor cold straightened, because it considerably alters their physical properties.

Large irregular-shaped forgings are best sampled by cutting out a sample bar with a hollow drill. In important cases both the thickest and thinnest portions of the metal should be sampled, because in wrought metal more "work" has been done on the thinner parts than on the thicker, and in cast material the difference in the rate of cooling (due to differences in thickness) often causes marked differences in the strength of the two portions.

Sampling Cast Alloys.

Cast alloys are sampled by test bars which are either cast on the actual castings, or separately. With some alloys it is highly necessary to record the casting temperature used. For this purpose the thermo-junction pyrometer manufactured by the Cambridge Scientific Company, is very suitable.

The methods of preparing test bars have so important a connection with the results of the tests that the author will instance a few of his experiences in this matter.

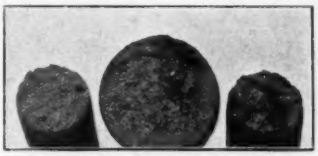
Moulds.

Either a (1) green sand, (2) dry sand, (3) loam, or (4) chill mould, can be used. Each gives different test results, the difference between the elastic limits sometimes amounting to 50 per cent. In ordinary everyday foundry practice, either green or dry sand moulds are invariably understood to be used. Therefore loam or chill moulds should not be used unless with the full knowledge of all parties concerned.

Position of the Mould while Casting.

Some foundries cast the bars in vertical moulds, others in horizontal, and others in slightly inclined positions. Most of these conditions influence the results, and it is important to record on the reports the exact conditions employed.

The author has experimented with test bars 1⅛ in. diameter by 15 in. long, and finds that with dry sand moulds the vertical method gives poor results if the alloy possess an eutectic solidifying at a low temperature. The eutectic segregates at a point about three-quarters of the way up the bar, especially if it is cast too hot and not fed. Such bars fracture at the



A. B. C.

FIG. 3.—A, SOUND, B & C, UNSOUND TEST PIECES.

point of maximum segregation, and have a characteristic cup and cone fracture due to the difference in strength of the inner and outer portions.

The horizontal method gives good results provided the metal is a clean metal, otherwise the "top side" is usually defective. The middle test piece in Fig. 3 shows top side defects, which were not visible on the outside of the casting. The inclined position usually avoids "top side" defects.

The vertical method gives good results with the majority of alloys, provided the metal is well mixed. It is the best for ordinary foundry tests.

Sampling Castings.

To ascertain the properties of an actual casting, the test bar should be moulded on it, so that the bar forms an integral portion of the casting as shown at A in Fig. 4. The bar should not be "run off" the casting as at B, because it leaves too much loophole for trickery.

Some firms habitually chill the test bars which they send away as samples accompanying their quotations, and the author has also disclosed instances where the sample test bar moulded on the actual casting had been surreptitiously chilled. This is a very reprehensible practice, as the bars are understood to be cast upon green or dry sand castings. It is done solely to obtain high test results, especially for the elastic limit.

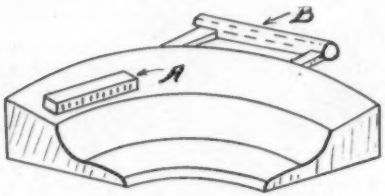


FIG. 4.—A, CORRECT, B, INCORRECT METHOD OF MOULDING THE TEST BAR.

An example illustrated in Fig. 5 shows evidence of this chilling. The glazed and crinkled surface of the chilled bar compared with the part where it joined on to the actual casting, should be noted. In this case a horseshoe-shaped steel chill mould was built in the sand in 1 in. widths. This chill formed the mould of

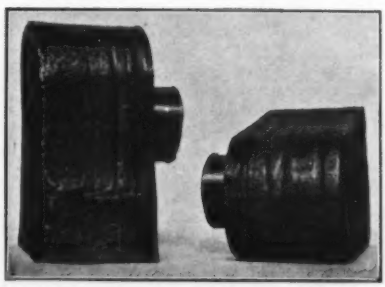


FIG. 5.—EVIDENCE OF CHILLING TEST BARS.

the test bar, but no other part of the casting had been chilled. The yield point of the chilled test bars determined according to the maker's specification, was 21 tons per square inch, but test pieces from the actual casting proved it was unsound, and that the yield point varied from 7 to 16 tons per square inch. The two outer test pieces A and C, in Fig. 3, are the actual test pieces. In some cases heavy chills are hidden just under the surface of the sand, close by the test bar; the latter, of course, becomes chilled. This is not so effectual as the first method described.

Another trick which has been used at times is to set a piece of hard forged metal in the mould, so that it becomes "burnt on" to the casting, and is itself surrounded by a thin layer of cast metal, which hides its true character and enables it to be passed off as a cast test bar. Inspection of the mould before shutting down would, of course, at once disclose the first and last tricks, and probing the sand with a venting tool would discover the second. But very often the inspector is not sent until the makers report the castings have been cast and fettled. It then becomes more difficult to prove such frauds. This species of dishonesty should always be most severely dealt with, for it not only means risking the safety of costly machines, but also the lives of their users, and others.

Tests and Test Pieces.

If compelled to select only one kind of test, the author generally decides upon the tension test. Torsion tests require special machines, such as the Avery torsion tester, or special attachments to a tension machine. Transverse tests, if carried beyond the elastic limit, degenerate into mere bending tests, which are not of so much value. Compression and shearing tests rank next to the tension test for general utility.

The shape and dimensions of test pieces vary according to which test is required. In a tension specimen there are three main parts, namely, the gauge length, or long parallel portion, the shoulders, which have a radius or taper, and the enlarged ends for gripping.

Rules for governing the design of tension specimens have been formulated. In France and Germany formulæ based upon the so-called "Law of Similarities," are used. The British War Office use the formula :—

$$l = 4 \sqrt{A},$$

where A = area of gauge length, and l = gauge length.

There are so many practical difficulties in using such formulæ that Americans have preferred more empirical standardisation, based upon fixed gauge lengths.

The system of standardisation now becoming orthodox in Great Britain is that

devised by the British Engineering Standards Committee.

TABLE II.—*Relation of Gauge Lengths to Diameters of Gauge Lengths.*

Gauge length diameter $(d)_1$.	Exact E.S.C. minimum gauge lengths.	Actual gauge lengths to be used with dia. $(d)_2$.
Inches $\left.\begin{matrix}\\\end{matrix}\right\}\times 9 = \left\{\begin{matrix}\\\end{matrix}\right.$	Inches.	Inches.
1.265	11.385	11.5
1.129	10.161	10.25
0.874	7.866	8.00
0.798	7.182	7.25
0.714	6.426	6 50
0.618	5.562	5.75
0.564	5.076	5.25
0.437	3.933	4.00
5.357	3.213	3.25
0.300	2.700	2.75

TABLE III.—*Relation of Grip Diameters to Commonly used Gauge Length Diameters.*

Grip Diameter D inches.	Gauge length dia., (d_1). Exact ratio $\frac{D}{4}\times 3$ inches.		Actual dia. (d_2) to be used for gauge length.	Equivalent area to (d_2) square inches.
1.75	1.313		1.265	1.250
1.50	1.125		1.129	1.000
1.25	0.938		0.874	0.600
1.25	0.938	or	0.798*	0.500
1.00	0.750		0.714	0.400
0.875	0.656		0.618	0.300
0.7·0	0.563		0.564	0.250
0.625	0.469		0.437	0.150
0.500	0.375		0.357	0.100
0.400	0.300		0.300	0.0707

* Use 0.798 in. dia. by preference.

For bar and rod materials there are two alternative E.S.C. gauge lengths, namely, $l=8d$., and $l=9d$., d=diameter of gauge length. The shorter one is for specimens tested without enlarged ends, the longer one for test pieces with screwed or other enlarged grip ends. The increase in length is necessary to prevent errors in elongation due to the proximity of the larger diameter of the grip ends.

The E.S.C. test pieces, A, C, D, and E, are quite acceptable, but there is an objection to their test pieces B and F when worked to the exact minimum ratio of gauge length and diameters specified; namely, the gauge lengths are irregular fractions which cannot be quickly marked off on the specimens. This is shown in Table No. 2.

A system of fixed gauge lengths, such as 2 in., 3 in., 5 in., 8 in., and 10 in., arranged in proper relation to the commonly used diameters (for diameters see Table No. 3), would be more practicable.

In fact, this is arrived at if we take the nearest whole number to the exact E.S.C. ratios. Table No. 3 also shows the correct relation for the diameters of the grip end (D) and gauge length (d_2). Gauge lengths must be uniform in diameter throughout their lengths, but the author's practice is to allow 0.001 in. uniformly above, or below the nominal diameter.

Grip Ends and Shackles.

Circular specimens should have screwed ends. When for economy it is desirable to avoid screwing the ends of specimens, use radiused shoulders and spherical seatings, but always avoid the slovenly method of griping round test bars in flat wedge-grips—it is most unsatisfactory.

Tension Tests.

Doubtless most foundrymen and engineers have seen tension tests performed. The stress or pull is gradually increased upon the specimen, which transmits it to the measuring lever, where it is balanced by the movement of the poise weight. With most metals the extension of the specimen is small at first, and it is easy to maintain the lever in balance. Supposing the specimen is a ductile metal or alloy; as the test continues, a load is reached at which the extension suddenly becomes rapid, and often it is not possible to keep the lever balanced (*i.e.*, floating). The load then has to be much more slowly applied.

This rapid elongation is practically uniform throughout the gauge length, and it forms a very distinct phenomena if the metal is ductile, but is not so apparent in hard metals. This point is variously named:—(*a*) The yield point; (*b*) breaking down point; (*c*) drop of the beam.

This rapid stretch only lasts a short time, and then the bar appears to recover its strength and again requires additional stress. (N.B.—Very few alloys show this "recovery of strength," hence they have no definite yield point.)

Continuing the test, a second load is reached, at which the stretch again suddenly increases rapidly, but this time no recovery of strength occurs, and, in fact, the greatest load the specimen will carry has now been reached. This load is therefore named the maximum load (or stress).

Looking at the specimen, it will be noticed it is now "drawing out," or "necking down" locally. That is, the diameter is decreasing at one spot much more than anywhere else. This second

rapid elongation is usually restricted to a length of about 1 in. of a gauge length, and if the specimen is accurately made and the metal is homogeneous, this local reduction of area occurs practically on the middle point of the gauge length. From this stage the test has to be continued by "backing" the weight on the measuring lever, *i.e.*, continuing to pull, but decreasing the load in order to keep the lever floating. Common sense, of course, shows this is necessary, because the area of the specimen continues to be rapidly reduced.

The operator continues reducing the load at such a rate that the lever remains floating until suddenly the specimen breaks. It breaks in the drawn down portion. The load on the specimen at the moment of actual fracture is called "the true breaking load" (or stress). In the case of ductile metals it is often considerably less than the maximum load. In harder metals, and most cast alloys, it may coincide with the maximum load, or be only a very little less. In ductile metal the breaking load requires both skill and time to accurately determine it, and for that reason few laboratories take the trouble to do so. They generally leave the poise weight standing at the maximum load until after the fracture occurs. This is slovenly practice, and it sometimes influences the elongations, reduction of area, and the appearance of the fracture. The true appearance of the fracture is not obtained unless the specimen is broken while the lever is floating. Hard metals usually fracture without much local reduction of area.

Many reports confuse the maximum load with the breaking load, by wrongly calling the maximum load the breaking load. The report should state the maximum load, as it is the most important of the two.

Stress Strain Diagrams.

If, before commencing the tension test, there is attached to the gauge length of the specimen an instrument which can indicate the stretch occurring with each increase of load, and the readings obtained within the whole test are plotted upon squared paper, making the loads "ordinates" and the elongations abscissae, it will be found that wrought ductile metals and mild steel give curves like the one shown in Fig. 6.

On the curve are lettered points which will now be described. The M.L. and B.L. stand for the maximum and breaking loads just described. T.E.L. stands for true, or theoretical elastic limit. It is connected with a theoretical conception regarding the behaviour of metals under pulling stress, namely: "That all metals behave within certain limits of loading, as though they are perfectly elastic bodies." This means that when loaded with a small load of, say, 2 tons per square inch, they stretch or elongate a certain amount, say, 0.0002 in., but upon removing this load they again recover their original length. It was supposed that by gradually loading and unloading in this manner, using increasing loads, a load is at last reached at which the material no longer has power to recover its original length, but instead, remains permanently stretched (elongated) by a small but definite amount. This permanent elongation is called a "permanent" set, and the load which produces the first permanent set is called the true limit of elasticity, or theoretical elastic limit.

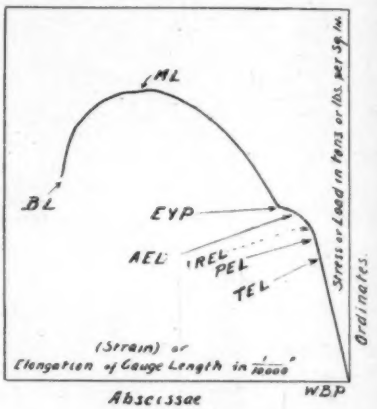


FIG. 6.

Experimenters have found that, truly speaking, few materials definitely possess such a point, but that a small permanent set occurs in some alloys and pure metals with any load, no matter how small, especially if the metal is in the dead-soft or annealed condition.

In other instances the so-called permanent set is not truly permanent; it gradually disappears, and only requires sufficient lapse of time to become immeasurably small.

The definition should thus preferably read:—"The true elastic limit is the stress at which permanent set first be-

comes visible (measurable)." This amendment, however, makes the true elastic limit depend entirely upon the delicacy of the instrument used for its measurement.

Considerable confusion has been caused between makers and users of alloys owing to each independently deciding what shall be considered the "first permanent set."

For instance, in a laboratory where the operators do not know how to use any instrument more delicate than a 6-in. rule and a pair of compasses, the author has found the "first permanent set" fixed at 0.01 in. on a 2-in. gauge length.

Others, using a kind of inside micrometer gauge, take a "set" of 0.003 in., or, in very rare cases, a "set" of 0.001 in. on 2-in. gauge length; while the Official Testing Laboratories of Germany, where are used very sensitive mirror extensometers, capable of showing extensions of less than $\frac{1}{300\,000\text{th}}$ of an inch, fix the point to correspond with a permanent set of about 0.00004 in. on 2 in.

Probably, for engineering work, a permanent set of 0.0005 in. on 2 in. is sufficiently accurate, while 0.001 in. is certainly the maximum allowable. This test is very slow, because of the necessity of unloading and reloading, which has to be performed at every increment of the stress of 1,000 lbs. per square inch.

The confusion gathered round this definition is such as to make it very desirable to abandon it for commercial work. Moreover, it is questionable whether the true elastic limit has any existence in fact, although it is still very useful in engineering to consider that materials are elastic for small loads.

Hook's Law.

The researches of Robert Hook in 1676 disclosed the fact that up to a certain point the elongations produced by loading are approximately proportional to the loads required to produce them. This law breaks down at large loads because of the permanent sets they produce.

This point is marked P.E.L. on the diagram, because it is called the proportional elastic limit.

It is defined thus:—

"The proportional elastic limit is the load (stress) at which the elongation (strain) ceases to be in proportion to the load (stress), and corresponds to the point where the line representing the strain (if shown diagrammatically by plotting the stresses as ordinates and strains as abscissae) departs from the straight."

This is a much more practical definition, and it is in use in Kirkaldy's and other British laboratories which do official testing.

It is the definition standardised for use in the British Thomson-Houston Company's specifications. It has a slight disadvantage of depending to a certain extent upon the delicacy of the instrument used, but it is quick because it does not require the unloading and reloading of the specimen, and a moderately coarse extensometer (reading to, say, 0.0001 in.

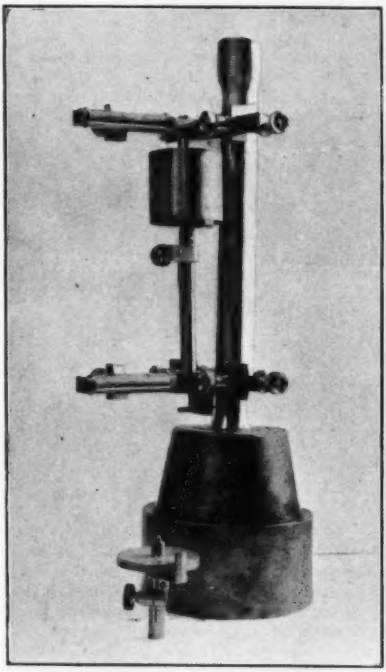


FIG. 7.—PROF. UNWIN'S MICROMETER EXTENSOMETER.

with accuracy) can be used for its determination. The instrument used by the author is shown in Fig. 7, it is known as Unwin's micrometer and spirit-level extensometer. This is graduated to read to $\frac{1}{10.000}$ths of an inch, and can be used for gauge lengths from 2 in. up to 12 in. When a 2-in. gauge length is used the graduated head lying in front of the shackles is used—it takes less space than the one fitted on the specimen. Usually, as soon as the proportional elastic limit

is passed, the instrument is removed and the maximum and breaking loads are then determined as usual.

This instrument is only suitable for vertical testing machines. (N.B.—It is not necessary to actually plot the curves; the P.E.L. can be read off from the test figures. However, it is preferable to plot the curve, because it eliminates experimental errors in individual readings.)

A new extensometer has just been designed by the Cambridge Scientific Instrument Company, Cambridge, England. It is shown in Fig. 8.

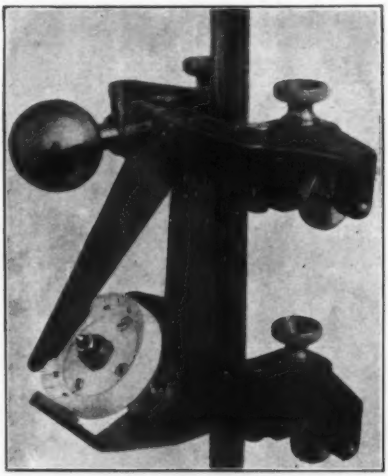


FIG. 8.—NEW CAMBRIDGE EXTENSOMETER.

At present it is only arranged to work upon a 200 mm. gauge length, but the author has urged them to make it applicable to all sizes from 2 in. to 12 in., because inspection of the instrument has convinced him it is suited to commercial testing. It is quickly adjusted and robust, and probably it could be applied to both vertical and horizontal machines. The micrometer screw has a ½ mm. pitch, the head is divided into 100 parts, each division on the head equals $\frac{1}{1,000}$ mm., and by the eye tenths of a division, or $\frac{1}{10,000}$ mm., can be estimated. It is not claimed the results are trustworthy past $\frac{1}{1,000}$ mm., (say, 0.00004 in.), but this is ample for determinations of the proportional elastic limit, and modulus of elasticity. It is time such instruments were used in works' laboratories for important work.

The next point on the curve is J.R.E.L., which stands for Johnson's relative elastic limit. It was proposed by Professor Johnson, of St. Louis, U.S.A., in 1891. He defines it as:—"The point on the stress-strain diagram where the rate of elongation is 50 per cent. greater than it is at the origin of the curve (*i.e.*, the minimum rate)."

He describes its determination as follows:—"Draw a tangent to the stress-strain diagram at the origin, and then lay a parallel ruler on a line, making with the load line an angle whose tangent is 50 per cent. greater than that of the original tangent line. Then move the ruler until its edge becomes tangent to the stress-strain diagram, and draw such tangent line; the R.E.L. is located by eye as this point of tangency."

Fig. 9 makes this clearer. Professor Johnson thinks we ought to adopt this in England, and call it the relative

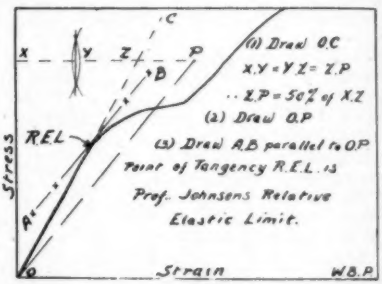


FIG. 9.

elastic limit. It certainly is time the E.S.C. standardised a definition for the elastic limit (not yield point), which should be applicable to all classes of metals. Personally, the author strongly favours the proportional elastic limit determined by extensometers, graduated to $\frac{1}{10,000}$ of an inch

The relative elastic limit is the next best suggestion, but it necessitates always plotting a curve, and is, therefore, not so quickly determined as the P.E.L. It necessitates the use of an extensometer, or an autographic recorder.

The next point, A.E.L., is the "apparent elastic limit;" it is defined as follows, and is often erroneously quoted as the true elastic limit:—

"The apparent elastic limit, is the stress which produces a permanent set equal to three-twentieths of 1 per cent. of the gauge length." It equals a 0.003 in. set on a 2-in. gauge length.

The letters E.Y.P. mean English yield point, as defined in Government specifications, thus :—"The yield point will be taken as that point at which the permanent elongation is 0.01 in. on a 2-in. gauge length."

This equals 0.5 per cent. of the gauge length. It has no value except as a very rough test for passing materials. Its use probably arises from the difficulty inspectors encounter in testing materials in badly equipped and staffed, laboratories.

Autographic Recorders.

The quickest commercial method for determining with accuracy the proportional, or relative elastic limit, is to use a properly designed autographic stress-strain diagram apparatus, of the mechanical type.

This should be designed to magnify the strain (elongation) not less than four or five times unity, and to work with three stress (load) scales, namely, 1 in. equals 10 tons, 1 in. equals 5 tons, and 1 in. equals 2.5 tons. The strain could readily be magnified to eight or ten times unity by suitably arranging the cords and clips on the specimen. This is a good method for works' use.

Unfortunately, many of the mechanical autographic apparatus supplied with machines are incorrectly designed.

We will now consider some results obtained upon commercial alloys in the form of test bars and castings.

The first are Professor Anderson's tests upon sterro-metal, cast at Woolwich Arsenal between 1854-1872, and tested with the Arsenal machine (see Table 4). These exemplify foundry practice of many years ago, also the method of testing then in vogue.

Assuming, for the sake of comparison, that the load producing 0.001 in. permanent set on 2 in. is approximately the proportional elastic limit, then the elastic limits are 8.9, 6.9, 7.1, 6.4, and 11.4 tons per square inch, with an average of 8.1 tons per square inch.

The average breaking load (really maximum load) is 20.1 tons per square inch, so that the proportional elastic limit is only 40.3 per cent. of the maximum load.

Chilled specimens had similar elastic limits at 14.8, 9.8, 15.5, 10.2, and 10.6 tons per square inch, which averaged 12.1 tons per square inch—an increase of about 34 per cent. upon the sand-cast metal. The breaking loads for chilled bars averaged 29.2 tons per square inch, an increase of 45 per cent. upon the sand castings.

TABLE IV. (*Anderson's Strength of Materials*). *Diameter of Specimen*, 0.707 *in. Gauge Length*, 2 *in.*

(1). Breaking Load, tons per square inch.	(2). Loads, tons per square inch.	(3). Elongations in inches.	(4). Permanent Elongations in 2 in. Gauge Length.	(5). Permanent Elongations per inch of length.	(6). Treatment.
	2.27	.001	—	—	Cast in sand.
	3.86	.002	—	—	
	6.02	.003	—	—	
	7.27	.004	—	—	
	8.98	.005	.001	.0005	
	10.40	.006	.0015	.00075	
	11.03	007	.002	.001	
	12.50	.008	.0035	.00175	
	13.07	.009	.004	.002	
20.35		.074	—	—	
	4.09	.001	—	—	Cast in sand.
	5.68	.002	—	—	
	6.48	.003	.0005	.00025	
	6.93	004	.001	.0005	
	7.73	.005	.0025	.00125	
	8.30	.006	.003	.0015	
	9.21	.008	.005	.0025	
19.78		.227	—	—	
	5.11	.002	—	—	Cast in sand.
	7.16	.004	.001	.0005	
	8.07	.005	.0025	.00125	
	8.41	.006	.003	.0015	
	8.75	.007	.004	.002	
	9.32	.009	.0055	.00275	
20.92	—	.282	—	—	
	4.54	.002	.0005	.00025	Cast in sand.
	6.36	.004	.0010	.0005	
	10.12	.006	.0025	.00.25	
19.21	12.50	.009	.0045	.00225	
	7.50	.003	.0005	.00025	Cast in sand.
	11.37	.005	.001	.0005	
	13.19	.007	.002	.001	
20.35	14.66	.009	.004	.002	

The ratio per cent. of limit to breaking load rises to 41 per cent., or an increase of only 1 per cent.

The curves in Fig. 10 represent modern foundry practice (in 1907) in the U.S.A. arsenal foundry at Watertown, Mass.

The proportional elastic limits are:—

	Per square inch.
(a) Dry Sand Casting,	11,000 lbs. = 4.9 tons
(b) Green ,, ,,	10,000 lbs. = 4.4 tons
(c) Chilled ,,	12,000 lbs. = 5.4 tons

The maximum loads are—

	Per square inch.
(a) Dry Sand Casting,	20,000 lbs. = 8.9 tons.
(b) Green ,, ,,	18,000 lbs. = 8.0 tons.
(c) Chilled ,,	29,000 lbs. = 13.0 tons.

There has been practically no improvement made in the proportional elastic limit. Of course, the compositions may not permit strict comparison, but still it is a remarkable fact. Note the effect of the different moulds, and compare with

the curves in Fig. 11, illustrating some tests made by the author this year on dry sand and chilled alloy test bars.

Here we have a low proportional elastic limit, but an improved maximum load. The "ferruginous brass" is comparable with sterro-metal.

fairly typical of what is produced to-day.

Note the low proportional elastic limits —only one report records any elastic limit over 14.0 tons per square inch.

The elongation is generally low when the elastic limit is high, and *vice versâ*, and yet engineers continue specifying 30

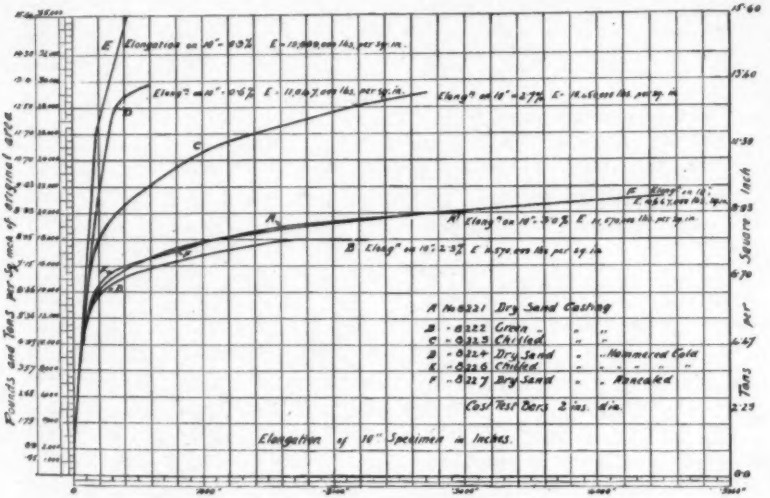

Elongation of 10" Specimen in Inches.
A No 8221 Dry Sand Casting
B " 8222 Green " "
C " 8223 Chilled " "
D " 8224 Dry Sand " Hammered Cold
E " 8226 Chilled " " " "
F " 8227 Dry Sand " Annealed
Cast Test Bars 2 ins. dia.

FIG. 10.—STRESS-STRAIN DIAGRAM. TENSION TESTS OF NO. 2 BRONZE.

Now what results do large castings give? Perhaps the largest and heaviest so-called bronze castings made, are propellers for steamers. They are nearly always moulded in loam.

per cent. elongation on 2 in.

In large thick unchilled castings the proportional elastic limit is never very high.

This is partly due to the slow rate of cooling, and it accords with experience

TABLE V.—*Tension Tests on Specimens Cut out of a Broken Bronze Propeller Blade, May*, 1884. *Report K.*

Position of specimen	Test. No.	Stress lbs. per square inch. Elastic.	Ultimate.	Ratio of elastic to ultimate, per cent.	Contraction of area at fracture, per cent.	Ultimate extension per cent. in 2 inches.
Cut out of central position.	1,697	7,900	30,273	26.1	31.4	42.5
	1,698	7,200	22,352	32.2	19.5	23.2
	Mean.	7,550	26,312	29.1	25.4	32.8
Cut out of edge position.	1,699	9,300	36,990	25.1	39.2	49.8
	1,700	8,600	34,930	21.7	36.4	46.1
	Mean.	8,950	35,960	23.4	37.8	47.9

By the courtesy of Messrs. David Kirkaldy & Son, the author is able to quote results of three investigations made by them upon broken propellers.

The oldest is dated 1884, but they are

gained with nearly all industrial alloys and pure metals.

The most authoritative text-books are full of warnings respecting the uncertainty and variableness of the physical

properties of alloys when cast in large castings, and the author's experience fully confirms this fact.

These results clearly indicate a most important fact *not* sufficiently well known to designing engineers, namely, "the proportional elastic limit," of the so-called high tension, or propeller alloys, when cast in large dry or green sand, or loam castings, is rarely higher than 14 tons per square inch, and averages about 9 tons per square inch." The very high elastic limits reported in advertisements cannot be genuine if they are claimed to apply to these alloys when cast in either dry or elastic limits are advertised, and engineers, therefore, specify them, in the belief that they are genuine, and may be readily guaranteed."

There would be fewer troubles in engineering if designers would accurately determine the proportional elastic limit of their metals, and would base their factors of safety upon these results, and not upon the maximum load or yield point. This particularly applies to large alloy castings, such as propellers. We should hear far less of breakages and other damages to propellers if, instead of changing designs to theoretically cure

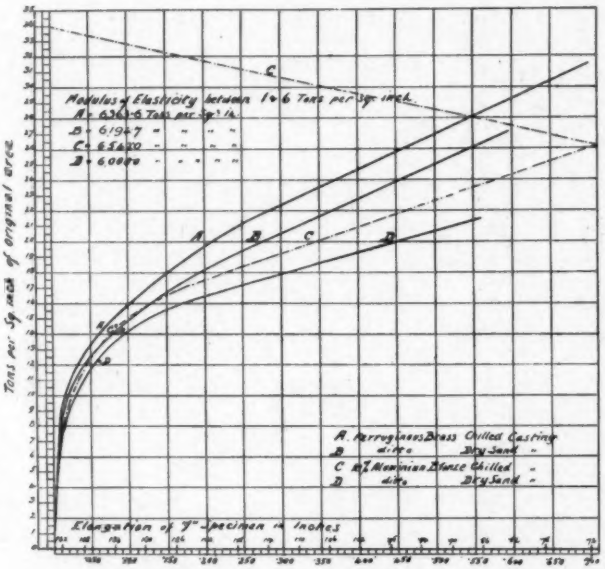

Modulus of Elasticity between 1 & 6 Tons per Sq. inch.
A = 6.36-6 Tons per Sq. in.
B = 6.1947 " " " "
C = 6.5420 " " " "
D = 6.0000 " " " "
A
B
C
D
A. Ferroglass Brass Chilled Castings
B " " Dry Sand "
C M.T. Manganese Bronze Chilled "
D " " Dry Sand "
Elongation of 7" Specimen in Inches

FIG. 11.—TENSION, STRESS-STRAIN DIAGRAM.

green sand moulds. Such results are usually yield points similar to E.Y.P. described above. It is very easy to obtain high maximum loads on these alloys, but the proportional elastic limit remains low, unless the metal is chilled or wrought. Heavy chilling considerably raises the proportional elastic limit, and will raise the English yield point 100 per cent. Some manufacturers of these bronzes systematically omit the elastic limit from their reports and advertisements.

Mr. Kirkaldy says: "Makers blame engineers for specifying too high an elastic limit. If this is so, it is because such fancied weakness in designs, the metal was completely and systematically tested. The author strongly advises thoroughly testing all broken castings, because the results are more trustworthy than those obtained upon test bars.

Generally speaking, for structures to be safe and to have long life in use, experience proves that the working stresses in the materials must be well below the proportional elastic limit of the materials; probably, on the average, not more than one-fourth of it, although under some conditions they may reach 50 per cent. of it.

It further shows it is unsafe to base factors of safety upon either the yield

point or maximum load of brass foundry alloys. Cast copper alloys almost invariably have a definite proportional elastic limit, but, correctly speaking, they have no definite yield point, and their maximum loads are largely influenced by local defects.

Discussion.

Mr. A. H. Hiorns, opening the discussion, pointed out that such tests were impossible at a technical school, for lack of the large quantity of material which must be constantly available. The mere testing of small pieces in a laboratory were not comparable to tests on a large scale. He was strongly impressed with the remarks about the qualification of experts in works. It seemed to him lamentable that men should be in a position to carry out very important scientific tests without having had anything like a proper training. The results of their tests were, unfortunately, reported. But it was still more unfortunate for the poor fellows themselves, who were little better than labourers all their lives, never being able to rise any higher, because of the lack of the necessary qualifications. The lecture had shown the necessity of studying various metals, even by those who had to deal mainly with cast iron. Many of the variations were due to the different temperatures, which, as Mr. Longmuir pointed out some time ago, were of the

Table VI.—*Results of Experiments to ascertain the Elastic and Ultimate Tensile Strength, etc., of specimens prepared from portion of Bronze Propeller Blade.*

Test. No.	Description.	Original.		Stress.		Ratio of Elastic to Ultimate.	Contraction of Area at Fracture.	Extension.		Appearance of Fracture
		Dia.	Area.	Elastic. per sq. in.	Ultimate. per sq. in.			In 2 inches.	In 3 incher.	
PP.	Fractured. See sketch	inch	sq. in.	lbs. tons.	lbs. tons.	Per cent.	Per cent.	Per cent.	Per cent.	
1,101	Stamped. A.F.T. on rim B on cut portion. S.E.B. No. 2 R., 14 ft. 1 f_8 in.	turned .793	500	32,000=14.3	48,400=21.6	66.1	6.8	5.0	4.3	Granular Sound
1,102	R. S. On blade near fracture. Brand. Stone's Bronze. London, 1905.	do.	do.	33,000=14.7	57,200=25.5	57.7	9.2	9.0	7.7	do.
1,103	Marked Indiana, 12/8, 1906, in paint.	do.	do.	34,500=15.4	49,450=22.1	69.8	5.6	4.5	4.0	do.
			Mean	33,167=14.8	51,683=23.1	64.5	7.2	6.2	5.3	

Results of Experiment to ascertain the resistance to Bending Stress Distance between supports —ten inches—Load applied at centre.

Test No.	Description.	Dimensions.	Stress.		Ratio of Elastic to Ultimate.	Deflection, inch, at.						Angle.	Effects.
			Elastic Total.	Ultimate total.		1,000 lbs.	2,000 lbs.	3,000 lbs.	4,000 lbs.	5,000 lbs.	6,000 lbs.		
PP.		inches. B. D. Planed.	lbs.	lbs.	Per cent.							Degrees	
1,101	See above. (Bent with outside of casting in tension.)	1.00×1.00	2,450	6,420	38.2	.032	.064	.109	.198	.410	.826	27	Cracked

greatest importance. The result was affected not only by the rate of cooling, but by the time the metal had been exposed to a certain high temperature. The only thing he regretted was the absence of the chemical analysis of the various manganese bronzes, which had certain results in which the variations seemed inexplicable, they were probably due to the amount of iron present, which would considerably modify the influence of the manganese. The introduction of ferro-manganese, even in very small quantities, might make a lot of differ-

TABLE VII.—*Results of Experiments to Ascertain the Elastic and Ultimate Tensile Strength, etc., of Specimens prepared from three Bronze Propeller Blade Stumps.*

Test No.	Description.		Original. Diameter.	Original. Area.	Stress. Elastic. Per sq. in.	Stress. Ultimate. Per sq. in.	Ratio of Elastic to Ultimate.	Contraction of Area at Fracture.	Extension Sets at. Length five inches. 30,000 lbs. per sq. in.	40,000 lbs. per sq. in.	50,000 lbs. per sq. in.	Ultimate.	Appearance of Fracture.	Ultimate Extension in Two Inches.
J J			Inch turned.	sq. in.	Lbs. Tons.	Lbs. Tons.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.		Per cent.
4171	Propeller Flange, S1, root of blade remaining, fractured.	From blade	.798	.500	25,000	61,730	40 5	14.0	0.36	1.92	4.98	10.6	Granular, sound.	11.0
4172	Stamped BC, No. 2R, 6 0, 17 ft. 18 in. (On rim) 8 ft. 2 in., 1/1, 16 ft. 11 in.	From blade	do.	do.	24.500	63,800	38.3	18.6	0.52	2.36	5.98	14.8	do.	16.0
4176	London, 1900. (Cast on)	From flange	do.	do.	24,000	52,830	45.4	16.4	0.48	2.16	5.74	7 6	Granular, slightly unsound.	9.5
		Mean			24,500=10.9	59,483=26.6	41.4	16.3	0.45	2.15	5.57	11.0		12.2
4187	Propeller Flange, S2, root of blade remaining, fractured.	From blade	.718	.500	23,900	44,710	53.5	11 6	0.62	3.34	—	5.7	Granular, irregular.	7.7
4188	Stamped BC, No. 3B, 16 0, 17 ft. 8 in. (On rim) 18 ft. 2 in., 1/1, 16 ft. 11 in.	From blade	do.	do.	23,900	53,900	44.3	12.8	0 56	2.80	8.40	11.0	Granular, sound.	13.0
4192	Stone's bronze, London, 1900. (Cast on)	From flange	do.	do.	23,000	43,650	52.7	11.6	0.66	3.32	—	4.8	Granular, unsound.	6 0
		Mean			23,600=10 5	47,420=21.2	50.2	12.0	0.61	3.15	—	7.2		8.9
4179	Propeller Flange, S3, root of blade remaining, fractured.	From blade	.798	.500	25,000	57,800	43.3	11.6	0 24	1.46	4.36	7.4	Granular, slightly speckled.	9.5
4180	Stamped 17 ft. 8 in. (On rim) 18 ft. 2 in., 1/1, 16 ft. 11 in.	From blade	do.	do.	25,000	63,600	39.3	15.2	0.32	1.64	4.60	11.2	Granular, sound.	13.0
4184	London, 1900. (Cast on)	From flange	.714	.400	25,700	67,490	38.1	18.5	0.30	1.54	4.58	14.6	do.	16.5
		Mean			25,233=11.3	62,963=28.1	40.2	15.1	0.29	1.55	4.51	11.1		13.0

been referred to, and which would have a very important bearing on the results. A good example of the difference was furnished by Muntz's metal which, at a certain temperature, would have hardly any strength, but if cast in chill would have a considerable amount. With regard to ence. With pure manganese they got more uniform results. Castings produced under the same conditions would yield absolutely the same results.

MR. F. J. COOK remarked that many of the points could be verified by those who had to test cast iron. He had ex-

perimented considerably with cast iron in regard to chills, and they had increased the strength as much as 84 per cent. with $\frac{3}{8}$-th thickness of chill. Though they had not experimented with test bars, they had proved the value of the practice of cooling. He would like to know whether any indication or notice had been taken of the condition of the bar along the parallel length close to the fracture? The condition of the stretched a clear definition were given of elastic limits, both in regard to steel and iron.

MR. C. F. GAYWOOD (Phosphor Bronze Company) said his firm had suffered very much through tests by untrained men. Temperature had everything to do with breaking strain, and with the same metal and the same casting temperature they would get the same result every time. He had found some bronzes, when cast in chill, weaker than when cast in sand

TABLE VIII.—*Results of Experiments to ascertain the resistance to deflection under a gradually increased Bending Stress.*

Distance between supports. Twelve inches. Load applied at centre.

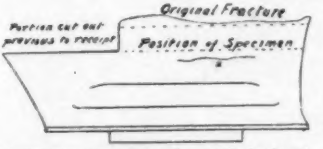
Test No.	Description.	Dimensions.	Stress. Elastic Total.	Stress. Ultimate Total.	Ratio of Elastic to Ultimate.	Deflection, inch, at 1,000 lbs.	1,500 lbs.	2,000 lbs.	2,500 lbs.	3,000 lbs.	3,500 lbs.	4,000 lbs.	4,500 lbs.	5,000 lbs.	5,500 lbs.	Angle.	Effects.
J J		inches. H D planed	lbs.	lbs.	per cent.											degs.	
4,173	Stump No. 1. From blade	1·00×1·00	1,900	5,500	34.5	.032	.051	.086	.133	.203	.350	.568	.901	1.38	—	56	Broken, sound, granular, uniform.
4,174	From blade	do.	1,750	5,275	33.2	.032	.057	.097	.155	.257	.441	.718	1.19	1.86	—	9	do.
4,177	From flange	do.	1,900	5,180	36.7	.032	.059	.092	.142	.256	.410	.697	1.09	1.61	—	46	do.
		Mean	1,850	5,318	34.8	.032	.056	.092	.143	.239	.400	.661	1.06	1.62	—	57	
4,189	Stump No. 2. From blade	1·00×1·00	1,500	4,152	36.1	0.33	.068	.118	.207	.370	.675	1.16	—	—	—	30	Broken, sound, granular, uniform.
4,190	From blade	do.	1,450	4,378	33.1	0.36	.078	.127	.243	.400	.800	1.31	—	—	—	49	do.
4,193	From flange	do.	1,500	4,225	35.5	.033	.070	.126	.237	.438	.780	1.38	—	—	—	41	do. irregular.
		Mean	1,483	4,252	34.9	.034	.072	.124	.229	.403	.752	1.28	—	—	—	40	
4,181	Stump No. 3. From blade	1·00×1·00	1,800	4,995	36.0	.035	.060	.092	.147	.235	.387	.657	1.09	—	—	34	Broken, sound, granular, uniform.
4,182	From blade	do.	1,900	5,270	36.1	.034	.062	.088	.136	.223	.369	.590	1.06	1.63	—	45	do.
4,185	From flange	do.	1,900	5,140	37.0	.034	.062	.091	.144	.229	.398	.620	1.05	1.65	—	41	do.
		Mean	1,867	5,135	36.4	.034	.061	.090	.142	.229	.385	.622	1.07	—	—	40	

part would show the stress in the pulling. The firm with which he was connected kept records, showing, not only ultimate strength, but breaking strain. The question of elastic limit was clearly equally the question of the limit of usefulness of any metal; and in view of the large amount of money spent by the Government upon tests in the National Laboratory it would be a good thing if but if they got a strong bronze in a chill, it would take a bigger strain. With a bronze of lower quality the chill seemed to weaken it.

MR. REES, on behalf of the Metallurgists, thanked the meeting for their invitation. With regard to trained testing experts, there was, in the North of England, a tremendous lot of testing by absolutely unskilled labour. At the same

time, in many cases great advantage had been derived in substituting, for such men, skilled labour from the technical schools.

Mr. F. M. Thomas thought the paper, which was of great practical value, had shown how very necessary it was that testing methods should be standardised. Some of the dimensions of Mr. Parker's test pieces differed widely from those usually employed. Some works adopted American methods, while others employed German. It was most desirable to have a standard which could be universally employed. The value of tests for comparisons was greatly reduced through the absence of uniformity, and such comparisons were very apt to be misleading. Some firms could test for



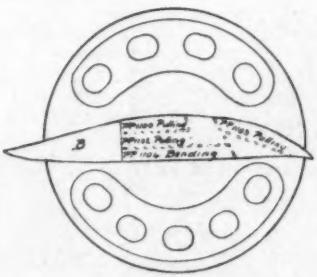


Fig. 12.

tensile strength up to 100 tons, whereas others could only test up to 50 tons. In cases where the bar had to be turned down, it was only the core of the bar that was being tested, and he had known a difference of as much as 2 tons in a steel which had been so treated. With regard to the testing of forgings, the hollow-drill method had been referred to. In America, it was usual to take two tests—one in the line of the axis, and one at right angles—and they were usually taken from the webs, because the web had a piece cut out. Perhaps that was better than forging a test piece. A test taken in the line of axis showed a result about 2 tons higher than one taken at right angles, or, as was commonly spoken of as "across the grain." They knew very well there was no such thing as "across the grain"; at the same time, the two tests gave that very marked difference. The information about the elastic limit was very valuable. With regard to the English yield point, although that did not indicate definitely the elasticity of the metal, yet, if taken every time, surely it did furnish some indication of the elastic limit, and was a very good indication relatively, while being much easier of attainment than either of the other methods. There was no one test which would reveal quality and suitability for different metals, whether cast iron, bronze, or steel. The information must be gleaned from a variety of tests. For example, if they took steel, which was very ductile, and would bend to 180 degrees, if tested for impact, by the Seaton and Jude method, it would break at the first blow. They would naturally conclude that the steel was rotten, but if they adopted another method it would stand a test of 200 tons, and would bend without a sign of fracture. With the Kirkaldy tests, he was surprised to find that there was the highest percentage of elongation, and the highest percentage of traction area, with the highest maximum stress. That was very unusual. He regretted there was nothing said about resistance to shock, which was a most important test in engineering works.

Mr. Jacks thought that Mr. Parker had somewhat summarily dismissed the deflection tests. He did not agree with him that they were of little practical value, especially in propeller building. They must remember that in propeller work there was little tensile strain. The strain was transverse, and the tendency was to break the blade off. If any of those blades had been subjected to a bending test, they would probably have never been put into the ship at all. If a propeller met with considerable transverse pressure, it would break off or bend. In such instances, the bending test was one of the most important things that could be applied, and if the propeller would not stand a good bend it would probably be thrown out.

Mr. Pass quite agreed that there should be chemical analysis, but he thought the metal would be all right if it were produced hot enough to give up its gases. Personally, as a brass-

caster, he had to use scrap to cheapen production, and he thought most of them did so.

Mr. R. Mason expressed the hope that the lecture would be published in full. In view of what had been said about the elastic limit, he thought influence should be brought to bear to secure a recognised standard.

The Chairman, moving a vote of thanks, thought they should also acknowledge the kindness and courtesy of the Thomson-Houston Company in allowing Mr. Parker to bring that information before them.

The resolution was carried with acclamation.

Mr. Parker, acknowledging, and replying on the discussion, agreed that the initial temperature of the castings had a very important bearing on the result obtained. Mr. Percy Longmuir's results were of very great value. With regard to the elastic limit, that was the true point in determining the value of materials for engineering purposes. The moment metal became stretched past that point there was no more contr[illegible] over it. As to the effect of chilling, he considered that chilling would have a marked improvement on the copper-tin alloys, which contain only 10 per cent. of tin, or from that to 15 per cent. His usual practice in testing forgings was to take samples from the forging itself, generally at a point midway between the centre and the outside of the forging. The "yield point" was of the more value in connection with steel than with alloys. With the latter, it was really out of date, and should be rarely used. He did not depreciate deflection tests, provided they were made within the elastic limit. Beyond that they were of very little use. (N.B.—The reports by Mr. Kirkaldy give also the deflection tests.) As regards the true breaking load, the real value was rather theoretical. He should strongly support the idea of writing to the Standardisation Committee. It would have a great influence if such societies as the Foundrymen's Association would stir up interest in these matters. The whole of those theoretical points were of practical importance. He regretted he was not authorised to also quote the analyses of the alloys.

On the proposition of Mr. Mason, seconded by Mr. Parker, and supported by Mr. Cook, a resolution was carried authorising a recommendation to be sent to the Standardisation Committee, requesting that authority to define a standard for the elastic limit.

Visit to Alfred Hickman, Limited.

The Birmingham Branch, on Monday evening, June 22, paid a visit to the blast furnaces and steel works of Messrs. Alfred Hickman, Limited, at Bilston.

As the charge of one of the blast furnaces was ready for tapping, this was the first operation witnessed. The establishment is famous for its labour-saving appliances, and the rapidity with which molten metal is removed from place to place. By this means heat is economised to the fullest extent, and the metal is never allowed to cool from the time it leaves the blast furnace until it is turned out in the form of finished bars from the mills. The molten metal, on leaving the blast furnace, is run into a large ladle, whence it is conveyed by locomotive to the mixer furnace and thence to the converter.

The mixer furnace is one of the most important and interesting features of the plant. With the aid of coloured glasses the visitors were able to look into the interior and see the flames passing over the metal. In this department a valuable labour-saving appliance is the Welmann charger, a large machine manipulated by electric power on rails in front of the furnaces, which periodically discharges its materials, including scrap, limestone, etc., into the furnace. From the converter the metal is poured into standing moulds in a vertical position, which, after the metal is cooled, are easily removed and cooled for the next cast. The ingots themselves are passed into soaking pit furnaces for the purpose of re-heating to the requisite uniformity and softness for rolling purposes.

A most important development, which is to be a feature of the establishment, is the new electrical cogging and bar mill now in course of erection. Special attention was devoted to the powerful engines in various departments. Of these, the most important is a gas engine, of 2,000 h.p., employed in compressing air for the blast furnace. Other engines, of 500 h.p., are employed in the operation of large dynamos for the generating of electricity.

A most important feature is the extent to which the firm are able to utilise their waste gases, being able, in fact, to drive most of their machinery by this means.

As showing the up-to-date arrangements, it should be added that every

facility is provided for constant analysis of the metal produced. In fact, on the completion of every cast a portion of the metal is at once taken to the laboratory and submitted to various tests, so that complete records are available, and the management are able to deal instantaneously with any metal which does not obtain the requisite standard.

The visit was brought to a close with the customary compliments, Mr. Buchanan moving a hearty vote of thanks to the firm, and for their courtesy in arranging the visit. The basic plant, he said, was understood to be the most extensive to be seen in the country, and they greatly valued the opportunity of seeing it.

Mr. F. J. Cook, in seconding, said it was a surprise to many of them to see so fine a steel plant in South Staffordshire. It was clear that in those works the steel trade was very much alive. He was much impressed by the great progress that had been made since his last visit some years ago. The use of such modern developments as the gas plant and the rolling mill extensions showed that the firm had no intention to be left behind.

Programme of British Foundrymen's Annual Meeting.

A COUNCIL meeting was held in Birmingham on June 27, at which the following programme was arranged for the annual meeting at Newcastle-on-Tyne, on August 4, 5, and 6:—

Tuesday, August 4 (morning):—Welcome to members by the Lord Mayor of Newcastle-on-Tyne. Papers:—"Sulphur and Phosphorus in Iron," by Mr. J. E. Stead (Bessemer medallist), F.R.S., F.I.C., F.C.S., Assoc.I.Mech.E., Middlesbrough; and "Securing the Co-operation of Workmen in the Improvement of Workshops and Workshop Methods," by Mr. R. W. Kenyon, Accrington. Afternoon:—Visits to the works of Messrs. Clark, Chapman & Company, and Messrs. Scott & Mountain, Newcastle.

Wednesday, August 5 (morning):—Papers: "Practical Application of Analysis to the Foundry," by Mr. P. Munnoch, Middlesbrough; limelight views, showing methods of work in the foundry, by Mr. J. Smith, Newcastle; "Theory and Practice in the Foundry," by Mr. G. M. Riches, Beccles. Afternoon:—Visits to the North-Eastern Marine Company and Palmer & Company, Jarrow. Evening:—Trip by special steamer to Tynemouth.

Thursday, August 6 (morning):—Visits to the works in Newcastle district. Afternoon:—Visit to Durham.

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THE SAMPLING OF PIG-IRON.

THE Birmingham Branch of the British Foundrymen's Association attended by invitation a meeting of the Birmingham Metallurgical Society, held at the Technical School, on Tuesday, June 2, Mr. A. H. Hiorns presiding. Three papers were read by members, namely, "The Sampling of Pig-iron," by Mr. G. Hailstone; "The Iodide Assay for Copper," by Mr. A. Spittle; and "The Microstructure of a Cartridge Case," by Mr. W. Ivan Taylor. Mr. Hailstone, whose paper we reproduce, is a well-known member of the Foundrymen's Association, who has previously contributed papers to that body as well as to the South Staffordshire Iron and Steel Institute.

The CHAIRMAN, in introducing the reader, remarked that Mr. Hailstone was thoroughly conversant with the subject, and his paper would be both practical and interesting.

MR. HAILSTONE then read the following paper:—

It is well-known that pig-iron is in no way a homogeneous material, but is a mixture of definite constituents, having widely differing freezing points. The distribution and segregation of these constituents depend upon varying conditions, three of the most important being:—(1) The temperature at which the iron is run from the blast furnace; (2) the time taken by the iron, when cast, to cool through the certain critical ranges of temperature; (3) the percentage of the different metalloids present in the iron, that form the different constituents.

The writer believes that the adoption, in this country, of a standard method of sampling pig-iron is very necessary. It must be borne in mind, however, that a standard method of sampling pig-iron must not be too elaborate so that it could not be adopted generally, but should be quick and accurate; also the sample should not be too bulky.

In some works, it is the custom when a consignment of pig-iron arrives, whether it is a 5-ton or 50-ton lot, for a yardman to be instructed to break a small piece

of the iron for a sample. The man generally picks out, for obvious reasons, the smallest or lightest pig of iron he can find, and breaks a piece from it. The piece of iron is then sent to the analyst to be analysed, as being an average sample of the bulk. When the analyst receives the sample he has to drill the iron to obtain drillings for analysis; he may or may not have a definite method of drilling. As I will point out later, it is of the utmost importance that the drillings taken from a pig of iron should represent the whole of that pig. I may point out here that drillings obtained by a good many of the methods used for drilling pig-iron do not represent the piece from which they are taken.

Now, going back to the sample of pig-iron taken, this piece, may or may not, represent the bulk in the first place. If not, no amount of proper drilling and careful work on the part of the analyst can produce an analysis which will be an average of the whole of the iron. On the other hand, if the piece of iron does happen to be an average sample of the bulk (which is very unlikely) and the drilling improperly performed, then the resulting analysis will be as far from the truth as ever.

A case of this description came before the writer's notice a few months ago. A consignment of about 20 tons of pig-iron was received from the blast furnaces. The silicon specified in this instance was 2.0 per cent., and not to exceed 2.25 per cent. An average sample was taken from the bulk, drilled, and analysed. The method of sampling and drilling will be described later. The silicon content of this iron was found to be 2.728 per cent., which is about one-half of a per cent. higher than it should have been. The bulk of the iron was again sampled, drilled, and analysed. The percentage of silicon found the second time was 2.735 per cent., which confirmed not only the first analysis being correct, but also the method of sampling correct.

Complaints were made to the furnaces, also a sample of the drillings were sent to them. The remaining sample taken at the furnaces was re-analysed by them, they still finding that according to the sample they were within their limits. The furnaces also analysed the sample sent to them, which they confirmed as 2.7 per cent. They also sent a portion of their original sample to the buyer, who confirmed the makers' analyses.

As a last resource the makers questioned the man who took the sample for analysis at the furnaces, and found that he had only submitted one piece of pig-iron from the whole bulk as an average sample, and agreed that their method of sampling was not fair. In choosing a method for sampling pig-iron it must be remembered that silicon and sulphur are unequally distributed in pig-iron from the same cast, but they differ very much in the manner of regeneration. Whilst silicon varies from pig to pig in the cast it is pretty evenly distributed in any one pig. Sulphur, on the other hand, is fairly equal in amount in each pig from a cast, but varies considerably in different parts of the same pig.

In the standard specifications for foundry pig-iron, adopted by the American Society for Testing Materials, in November, 1904, the method stated for sampling reads thus: —

"In all contracts where pig-iron is sold by chemical analysis, each carload, or its equivalent, shall be considered as a unit. At least one pig shall be selected at random from each four tons of every carload, and so as to fairly represent it. Drillings shall be taken so as to fairly represent the fracture surface of each pig, and the sample analysed shall consist of an equal quantity of drillings from each pig, well mixed and ground before analysis."

"In case of a disagreement between buyer and seller, an independent analyst to be mutually agreed upon shall be engaged to sample and analyse the iron. In this event, one pig shall be taken to represent every two tons. The cost of this sampling and analysis shall be borne by the buyer if the shipment is proved up to specifications, and by the seller if otherwise."

This method of sampling is very good as far as it goes. The portion dealing with the taking of the sample is without question good, but the portion referring to the drillings being taken so as to fairly represent the fracture surface is very vague. What it means is that if the fracture surface of the pig exhibits both open and close-grained portions, drillings should be taken from each in amount according to the amount present of each. I think here a definite method of drilling should be stated, as this is a most important point, and I think I can prove by experiments I have made there is only one best method of drilling pig-iron.

The method adopted by the writer is as follows: (It may be added here that this method has proved itself most satisfactory, both when a quantity of iron has been re-sampled and re-analysed;

also, which is of the greatest importance, that analyses of the resulting irons made from irons mixed by the aid of the analyses of samples taken this way agree absolutely with the calculated analyses of the mixtures.)

From every five tons, or part of five tons, of pig-iron in a consignment, one pig is taken. When a consignment is of five tons or less two pigs are taken to make certain an average sample has been obtained. Each pig of iron is broken into three parts, one part consisting of the sample. Thus, from a consignment of 27 tons of iron, the sample would consist of six pieces of pig-iron.

The samples of pig-iron are well brushed with a strong wire brush, to remove any adhering particles of sand. The outside skin on the top and bottom of the samples is removed either by machining or grinding off. The pig-iron is then drilled right through from top to bottom by means of a $\frac{1}{2}$ in. twist drill. The drillings from the various pigs that form the sample are then mixed well together and finally ground up fine by means of an agate mortar, and pestle. The sample is then ready for analysis.

The method of taking drillings I believe to be the best is, as before stated, by drilling the pig-iron through from top to bottom. Another method used is to drill six holes 0.5 of an inch in diameter, and 1 in. deep into the face of the pig-iron fracture. This latter method is advocated by Mr. W. B. Parker; the reason given for it being the best is that a piece of pig-iron is three times wider at the top than at the bottom. Therefore, three times as many drillings should be taken from the top as from the bottom of the pig. The writer has yet to see pig-iron of this section. The writer had lately conducted experiments to find out, if possible, the better method of the two. The procedure was as follows:—A piece of pig-iron was cut 2.5 in. long, the outside skin being ground off. The one end of the piece of iron was marked No. 1 and the other end No. 2. A thickness of 0.25 in. all over was machined off each end of the pig-iron. The swarf obtained

FIG. 2.—PIG-IRON, A.

was ground up and marked No. 1 and No. 2 samples respectively. In this way a correct sample was obtained off both ends of the piece of pig-iron. The ends of the pig-iron were then polished and a sulphur print taken from them to see how the sulphur was distributed in the iron.

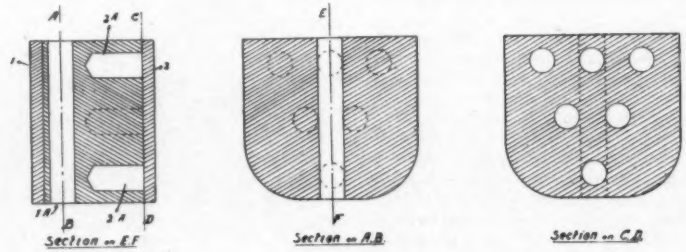

FIG. 1.

In all the experiments made the one end was a duplicate of the other regarding the segregation of the sulphur as shown by the sulphur prints. From the end of the pig-iron marked No. 1 as near as possible to the edge it was drilled right through from top to bottom; the drillings obtained were ground up and marked "Sample No. 1 A." From the end of the pig-iron marked No. 2 six 0.5 in. holes 1 in. deep were drilled into the face of the iron, the drillings ground up and the sample marked "No. 2 A." The

drawing (Fig. 1) shows exactly how the samples were obtained. Three pig-irons were treated in this way, and the results obtained were as follows:—

Fig. 2 is a sulphur print of pig-iron A
Fig. 3 „ „ „ B
Fig. 4 „ „ „ C

(With regard to the sulphur prints, it may be explained that these have been taken on the new principle lately suggested by Professor Baumann, and adopted and improved by Mr. Stead. In this system the print shows the segregation of sulphur in the pig, its location and extent being indicated by the dark appearance of the print.)

	Sample No.	Silicon.	Sulphur.	Phosphorus.
PIG-IRON A.—Sulphur evenly distributed throughout pig	1	2.225	0 162	1.647
	1A.	2.223	0.161	1.640
	2	2 280	0.159	1.665
	2A.	2.246	0.160	1.668
PIG-IRON B.—Sulphur segregated towards top of pig	1	1.107	0.126	0.935
	1A.	1.108	0.126	0 036
	2	1.110	0.127	0.035
	2A.	1.098	0.160	0.056
PIG-IRON C.—Sulphur segregated from centre to top of pig	1	1.230	0.035	0 509
	1A.	1.235	0.035	0.512
	2	1.232	0.034	0.510
	2A.	1.234	0.050	0.621

In each case the analyses were performed in duplicate and the mean of each taken. From these results it is seen that by drilling the pig-iron right through from top to bottom the most consistent sample is obtained. Except in pig-iron "A," where it is shown by the sulphur print that the sulphur is evenly distributed throughout the pig, and as phosphorus always follows sulphur, that the phosphorus also is equally distributed throughout the mass, the percentages of Si., S. and P. agree in the samples "1," "1 A," and "2," but the percentages of the sulphur and phosphorus in the samples taken by the "2 A" method differ very much owing to segregation in the irons "B" and "C." Therefore, without hesitation, I should say that the quickest and most accurate method of drilling pig-iron for analysis is to drill right through the centre of the pig from top to bottom.

In conclusion, I should like to point out how very necessary it is that the pig-iron drillings should be ground up fine before weighing out a sample for analysis, especially when graphite or total carbon is to be estimated. As a matter of fact, I have known the percentage of graphite ground in a sample of pig-iron to exceed the percentage of total carbon in that same sample by three- or four-tenths of a cent. This is due to the

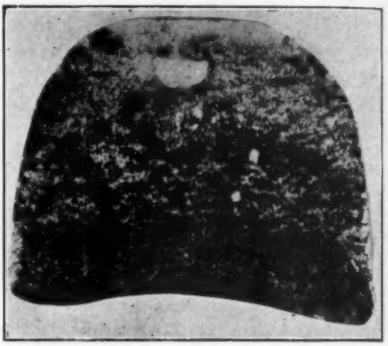

FIG. 3.—PIG-IRON, B.

fact that the pig-iron is harder in some parts than others and the drillings range from fine dust to fairly large pieces, the carbon in the different sized drillings varying considerably, as

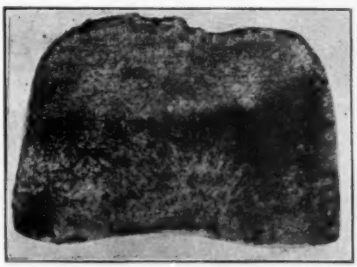

FIG. 4.—PIG-IRON, C.

shown by the following experiment which I performed:—

Six grammes of cast-iron drillings were well mixed up together. Two samples, of one gramme each, were ground up fine in an agate mortar, and the total carbon estimated. The percentage of total carbon found was 3.662 per cent.

The remaining four grammes of the unground sample were divided into two-gramme lots. Each lot was sieved through a 30, 60, and 90 mesh sieve, the portions remaining on, or going through each sieve were weighed, and the total carbon

estimated in each sample. The following table shows the results obtained, and also shows how very necessary it is to obtain from a true sample of drillings a much smaller true sample for the actual analysis: —

	Weight in grammes.	Percentage of sample.	Amount in grammes of carbon ground.
Sample of iron ground up fine	1.000	100	0.0362
Sample of iron not ground up—			
Iron left on 30 sieve ...	1.104	55.20	0.0312
Iron left on 60 sieve ...	0.530	26.50	0.0165
Iron left on 90 sieve ...	0.210	10.50	0.0071
Iron passed through 90 sieve	0.153	7.65	0.0150
Total	1.997	99.85	0.0728
Loss of sample on sieves...	0.003	0.15	—

	Percentage of carbon in each individual sample.	Percentage of carbon in original pig.	Percentage of the total carbon
Sample of iron ground up fine	3.662	3.662	100.000
Sample of iron not ground up—			
Iron left on 30 sieve ...	3.0978	1.710	46.977
Iron left on 60 sieve ...	3.1132	0.825	22.664
Iron left on 90 sieve ...	3.3666	0.355	9.752
Iron passed through 90 sieve	9.8039	0.750	20.604
Total	—	3.640	99.997

From the few remarks I have made upon this very important, but much neglected process of sampling, I think it will be agreed how very necessary it is that a standard method of sampling and drilling pig-iron should be adopted.

The CHAIRMAN, in opening the discussion, said that the brevity of the paper was an advantage, and the undue length of some of the papers was undoubtedly a fault which reduced the time for the discussion. He would like to know how Mr. Hailstone had managed to drill a hole, let alone half-a-dozen, through a piece of white iron, or any sample of hard pig-iron, and what kind of drill he used? (Laughter.) It was of the utmost importance that they should have a characteristic sample of the whole pig. In regard to cast-iron, they frequently noticed that the distribution of graphite or the extrusion on the surface was more considerable in one part than another. That was, no doubt, largely due to the rate of cooling, or to the long time that the specimen had been exposed to a high temperature. They frequently noticed a kind of casing graphite on the surface. If they took a sample from a piece like that without taking the precaution to remove the skin, they would get a very erroneous result with regard to the quantity of graphite.

PROFESSOR TURNER complimented the reader of the paper on the progress he had made during the last few years, especially in the way of securing increased accuracy. Mr. Hailstone was realising the importance of certain questions which were only impressed upon those who had been engaged in practical work for some time. There was no doubt that the sampling of pig-iron was a question of extreme importance. Defective samples were worse than useless, and they were the more misleading when they were handed over to an analyst who was known to be reliable. He was not sure whether one sampling method would answer for all pigs, and if the material was irregularly distributed they could not make any calculation. If they took a vertical section they would not in all cases get a fair percentage of the sulphur, but they might correct that by turning the iron and drilling it in another way. It seemed that the method suggested was the nearest approach to perfection they could get.

PROFESSOR STANSBIE remarked that if he had to analyse a pig he should want to see the sampling part of the work done.

MR. HAILSTONE, replying, said that he had not had much experience with white iron, having dealt mainly with grey and mottled iron. But one method adopted of sampling any very brittle material was to knock off four or five pieces of the iron and grind them up. That was the method employed for manganese. He had distinctly stated that pigs should be drilled from top to bottom, and not from side to side. A sample taken by cutting slices off would be a true sample of the pig. His own practice was to personally select the samples, because he found that if it was left to the man in the yard he would pick up a bit out of a corner of the truck rather than trouble to break whole pigs.

A hearty vote of thanks was accorded Mr. Hailstone.

AMERICAN FOUNDRYMEN'S ANNUAL CONVENTION.

NEARLY 1,000 members and guests of the American Foundrymen's Association registered their names on the opening day of the twelfth annual Convention at Toronto. The exhibition of foundry equipment and supplies, as well as the meetings of the Convention were held in the Toronto fair grounds. At the opening session, on June 9, Mayor Oliver, of Toronto, delivered the address of welcome. Responses were made by President Flagg, for the American Foundrymen's Association; Mr. C. J. Caley, for the Brass Founders' section; Mr. E. H. Mumford, for the Supply Men; and Mr. W. S. McQuillen, for the Foundry Foremen.

President Flagg's opening address was devoted to a review of the development of the American Foundrymen's Association and its labours in the years of its existence. While giving every praise for the good accomplished, the results of which had been of incalculable benefit to the foundry trade all over the world, he said that still further strides would have to be taken, not dreamed of when the organisation was founded, to justify its existence and claim the continued attention of scientific men. To maintain the pace that had been set and accomplish the definite results expected of the Association, more money than had hitherto been paid into the treasury of the organisation would be required, and he put forth, as a matter for consideration at this meeting, the advisability of increasing the membership dues to provide these funds. He thought metallurgy and the more scientific side of foundry operations should be given greater attention in the future than had been allotted them in the past, and in this connection he deplored the lack of interest and assistance given by chemists and metallurgists to the work in hand.

Dr. Moldenke read his report as secretary and treasurer, in the course of which he said the present membership is 730, including 67 in Canada.

In order to make the work of the American Foundrymen's Association more effective and to secure a greater unity of action among the allied organisations, a plan has been proposed whereby the affairs of the various societies will be centrally managed, and yet each association will retain its identity. This would mean the publication of all proceedings and contributions in one journal, thereby preserving much valuable literature which at the present time only indiscriminately finds its way into print. The plan was tentatively outlined by Dr. Richard Moldenke at the annual meeting of the Associated Foundry Foremen on June 8, and it was likewise discussed by the Executive Committee of the American Brass Founders' Association. The Foundry Foremen appointed a committee to consider the proposition, and this body will be empowered to act with the other organisations during the year.

A Most Successful Convention.

THE Convention came to a close Friday, June 12. The attendance was the greatest ever recorded, and the number and variety of exhibits were also the most complete ever shown.

The meeting adjourned with the recommendation to the Executive Committee that the invitation of the Cincinnati foundrymen and business organisations to hold the 1909 Convention in that city be accepted.

Mr. L. L. Anthes, of the Toronto Foundry Company, Toronto, Ontario, was elected president of the Association for the ensuing year. The other officers elected were the vice-presidents:—Messrs. F. B. Farnsworth, Wm. H. Parry, H. E. Field, J. W. Jeffrey, Samuel T. Johnson, T. W. Sheriffs, J. W. Kissick, and R. J. Cluff. Secretary and treasurer:—Dr. Richard Moldenke, Watchung, N.J.

The retiring president, Mr. Stanley G. Flagg, jr., was elected an honorary member.

At the concluding session, a motion was passed favouring the abolition of grading pig-iron by numbers and the substitution of a system in which chemical analysis will be the determining factor. The American Society of Testing Materials were also requested to co-operate with the Foundrymen's Committee in the matter.

Thomas D. West, Sharpsville, Pa., was appointed chairman of a committee to make an investigation of the causes of accidents in foundries and submit a report on the same at the next annual Convention.

Cost Committee's Report.

The Secretary read this report, which stated that the Committee recognises that it is impossible to lay down hard and fast rules regarding the details of figuring costs, making estimates and basing tenders, but at the same time they feel that the best interests of the

foundry business demand some degree of uniformity in the basic principles on which costs are figured. Accordingly, a chart outlining the main divisions of costs has been prepared by Mr. H. Emerson. The Committee only endorse this chart for general use so far as main divisions are concerned; details must be arranged in each instance according to the requirements of individual plants.

Foundry Foremen.

The annual meeting of the Associated Foundry Foremen was held on June 8, and F. C. Everitt, secretary, reported a growth in membership of more than 100. Officers for the ensuing year were elected as follows:—Mr. W. S. McQuillen, Warren, Pa., President; Mr. H. J. Holmes, Cincinnati, first Vice-President; Mr. J. Gaffney, Montreal, second Vice-President; Mr. C. E. Hoyt, Chicago, Secretary and Treasurer.

F. C. Everitt, to whose efforts the growth of the Association is largely due, insisted upon the acceptance of his resignation as secretary.

American Brass Founders' Association.

Apart from the joint session with the American Foundrymen's Association, the members of the American Brass Founders' Association held four meetings. In his presidential address, Mr. Chas. J. Caley suggested the appointment of a committee whose duty it would be to carry on research work along metallurgical lines in the non-ferrous metal industry.

The Secretary reported 145 members enrolled, the recipts for the year amounting to $725, and after all expenses had been defrayed a balance of $245.45 remained. A paper entitled "Electro-Chemical Cleaning of Metals and its Application to Commercial Uses," by Chas. H. Proctor, Arlington, N.J., was read by Mr. W. M. Corse. The author traced the development of electro-chemical cleaning baths, explained the arrangement of the same, the solution that should be used to obtain the best results and the method of operation.

Oil-burning furnaces, their efficiency, cost of operation, etc., were discussed at the Thursday morning session. Mr. F. A. Coleman, opened the discussion by briefly reviewing the various types of oil-melting furnaces in use. He suggested that information regarding the quality of metal produced under varying conditions and in variable types of furnaces would prove valuable to foundrymen. A paper on "The Value of Liquid Fuel in Brass Foundry Practice" was presented by Mr. W. N. Best, Brooklyn. The meeting closed with the reading of a paper on "Commercial Insulation," by Mr. F. H. Dimock.

"Prolonging the Life of a Crucible," was discussed by Mr. Dudley A. Johnson, of the Jos. Dixon Crucible Company, on Thursday afternoon, and this was followed by a paper on "The Metallurgy of the Bronze Age in Europe," by Mr. W. M. Corse. Other papers read at this meeting included "The Relation Between the Physical and Chemical Characters of Moulding Sands," by Dr. Heinrich Ries, and "Quality *versus* Quantity," by J. N. Gamble.

The meeting closed with the election of officers. Mr. Chas. J. Caley was re-elected president, and Mr. W. M. Corse, secretary.

The Foundry Supply Association.

The business meeting of the Foundry Supply Association was held on June 11, when the report of the Secretary-Treasurer was received. Mr. F. N. Perkins, Arcade Manufacturing Company, Freeport, Ill., was elected president, and Mr. H. M. Lane, Cleveland, Ohio., secretary.

DISCUSSIONS.

Automobile Cylinder Manufacture.

Mr. J. J. Wilson, referred to the pickling of automobile cylinders as having advantages and disadvantages. If the core sand is not all out of the water chamber, which it is impossible to ascertain without breaking up the casting, the pickle will harden the sand and later treatment will not remove it. Tumbling will jar it out, however, where there has been no pickling, particularly if the tumbler has been packed by an expert, in which case cleaner cylinders can be got than by pickling. He had used manganese for cylinder castings, sometimes introducing it into the ladle and sometimes in the cupola. He preferred buying pig-iron with sufficiently high manganese to introducing the manganese separately into the cupola mixture or into the ladle.

Mr. W. A. Jenkins, Oldsmobile Company, Lansing, Mich., presented the analyses of 12 automobile cylinders, one of which No. 3, was made in France

and the others in the United States. These analyses are as follows :—

No.	Total carbon.	C.C.	Mn.	S.	Si.	Phos.	Tensile strength. Lb.
1	3.35	.51	.43	.094	2.31	.05	22,360
2	3.02	.43	.22	.053	2.70	.463	18,970
3 Fr.	3.47	.40	.40	.102	2.45	.717	17,940
4	3.34	.10	.469	.083	2.59	.566	15,880
5	3.04	.08	.322	.10	2.55	.820	19,750
6	3.24	.098	.385	.111	2.67	.733	23,930
7	3.34	.59	.525	.084	2.30	.807	22,900
8	3.74	.65	.410	.083	1.60	.536	18,460
9	2.87	.028	.440	.159	3.56	—	25,030
10	3.52	.624	.476	.091	1.72	.578	25,260
11	3.91	.02	.824	.068	1.67	.444	21,330
12	3.61	.75	.518	.093	1.38	.620	14,710

In answer to a question Mr. Jenkins said there was no specification as to hardness, though in his opinion it was possible to get too soft iron for cylinder work in the effort to get castings that will machine readily.

Mr. F. W. Stickle presented analyses of the castings made in his shop, taken six months apart :—

	Total Carbon.	C.C.	Phos.	Mn.	S.	Si.
April, 1907 ...	3.17	0.45	0.65	0.39	0.13	1.89
October, 1907...	3.34	0.76	0.70	0.39	0.09	1.89

No tensile tests are made, but all test bars are broken transversely. The aim is to get iron with the greatest elastic limit, since the withstanding of shock is an important factor. With a 1-in. test bar, 12 in. between supports, cast-iron of the above analyses showed 3,800 lbs., breaking strength with deflection of 0.15 in. The speaker gave the following analysis of a French cylinder used on a Mercedes car, the principal difference from his own cylinders being in the higher phosphorus :—Total carbon, 3.36; combined carbon, 0.10; phosphorus, 0.83; manganese, 0.60; sulphur, 0.09; silicon, 2.29. The higher phosphorus content in the French cylinders Mr. Stickle considered to be a great detriment.

Moulding Machines.

Mr. E. H. Mumford, Philadelphia, was on the programme to open a discussion on "Moulding Machines," and he did this by presenting a series of questions on the matter. He read a letter from one who had had considerable experience with moulding machines, and who considered that progress with them had been slow. Had they been introduced as aids to moulding and not purely as machines, the writer thought greater results might have been reached by this time. Mr. Mumford asked whether there is not a commercial basis on which the moulding machine might be better operated by a moulder than by untrained labour.

Views were freely interchanged, one speaker expressing the idea that the present more tolerant attitude of the moulder toward the machine simply resulted from the sucess attained with the machine in spite of the moulder's long unwillingness to use it. On the other hand, it was argued that if the moulder is now willing to meet the manufacturer half way and to give the moulding machine a square deal, this is the time to make an arrangement with him.

Mr. S. C. Gale believed that if the moulder would take hold of machine work with the same spirit that he showed in hand-work, there would be a very much smaller contribution to the scrap heap. The difficulty he had encountered after every effort to adjust machine work on a fair basis and to distribute the tasks of setting cores, tempering sand, etc., and using picked men, was that when the moulders reached on the machine the same output that they had formerly regarded as a day's work with hand labour they thought their day's work finished.

Mr. G. S. Custer, remarked that the pouring of the moulds was an important factor in connection with machine work. A man cannot be expected to make 300 moulds a day on a machine, then pour the moulds and shake out. It is a physical impossibility. Where a man performs the variety of operations above referred to he should have more pay than for performing one. When a machine operator becomes thoroughly broken in to that work, it will be found that he will prefer a hand job to the machine job, and this is natural. The speaker emphasised the point that it should be made an object to a man to take hold of the machine and work up to the large outputs expected from its use.

The discussion was resumed at the afternoon session, the first question raised being "What part of the work of machine moulding is getting sand to the machine and getting the moulds off the machine to the floor?" No very definite data were brought out in answer. Mr. S. S. Knight told of an experience with the moulding of soil pipe tees. The actual moulding operation amounted to 50 per cent. of the cost. It was found in this particular work that it was impossible to get the sand to the machine and the moulds away from the machine and poured at anything like a fast enough rate to get the full output from the machine.

The Chairman, Mr. Flagg, called attention to the effect of the various

operations connected with machine moulding upon the character of the sand. Oftentimes the sand balls in a horizontal conveyor, the clay separating from the silica. Where machine operations are multiplied and a large number of men is involved, the gain from machines is not so great as might be inferred from the result with a single machine. In this connection Dr. Moldenke remarked that in German foundries much is being done of late in the direction of sand handling economies. Very soon much data should be available from Germany on this subject.

Mr. L. Kahn, speaking of the moulding machine from the standpoint of a stove manufacturer, said that ultimately the chief beneficiary of the moulding machine will be the moulder himself. The day may come when the skilled moulder will direct the machine operations of others not his equals in skill. With from 250 to 500 pieces in a stove the application of the machine to that industry has special problems, and the case is not nearly so clear as with work on single pieces like tees, where there are many to make, and are all alike.

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TITANIUM IN CAST-IRON.*

By Dr. R. Moldenke.

Among the numerous applications of electrical energy, none stands higher in the eyes of the iron and steel metallurgist than the electric furnace. Ferro-alloys containing metals formerly regarded as practically infusible can now be obtained for simple addition to the ladle, and their effect studied. The reduction of the cost to a commercial point has brought us nearer to the much sought goal of physical perfection in our iron products.

Of the two methods of preparing titanium for use in iron, the aluminothermic and the electric furnace, the latter seems destined to make the cheaper product; and as the selling price of a 10 per cent. titanium iron alloy is now within commercial limits, its use for the foundry is worth considering closely. For this purpose a series of tests was instituted on behalf of the American Foundrymen's Association. In the preliminary tests two classes of alloys were tried, one in which the material was free from carbon, and the other having some 5 per cent. of this element present. The tests showed that while both alloys could be used for the rather small quantities of iron treated, the carbon titanium alloy was better adapted for foundry work, as the melting point is lower. However, the alloy free from carbon can be used in the foundry where large bodies of metal are to be treated, and time can be given for a thorough incorporation of the material.

The apparent infusibility of the titanium iron alloys has, therefore, militated heavily against their use, and hence a word about this matter. When the lumps of alloy are thrown into the ladle, they must be given time enough to heat up and alloy with the bath by thorough stirring. This takes some time, and usually, especially with steel, fear that the metal may cool too much results in pouring before the titanium has done its work. Hence the writer suggests that where large lumps of either alloy are used, they be heated up to redness in any convenient way before use.

A summary of the results of the tests is as follows: —

	Grey.	White.
Original iron ...	(9 tests), 2,090 lb.	(8 tests, 2,050 lb.
Plus 0.05 Ti. ...	(4 tests), 3,100 lb.	(11 tests), 2,400 lb.
Plus 0.10 Ti. ...	(3 tests), 3,030 lb.	
Plus 0.05 Ti. and C ...	... (6 tests), 3,070 lb.	(9 tests), 2,420 lb.
Plus 0.10 Ti. and C ...	... (6 tests), 2,990 lb.	(10 tests), 2,400 lb.
Plus 0.15 Ti. and C ...	... 4 tests), 3,190 lb.	(10 tests), 2,520 lb.
Total tests and aver. strength	23 3,070 lb.	40 2 430 lb.

Increase in strength treated iron over original, Grey, 52 per cent.; White, 18 per cent.

From the above summary it will be seen that the greatest increase in strength was in the grey iron. This is of interest in connection with the recent tests made with vanadium in cast-iron where the contrary was observed. The improvement in grey iron is more marked than was the case in tests made by Mr. Rossi and the writer in 1902. The same peculiarities, however, were observed in the behaviour of the metal, as will be described later.

The Effective Quantity of Titanium.

Looking over the averages above presented, it will be noted that the improvement is almost as marked whether 0.05, 0.10, or 0.15 titanium was used, which would seem to indicate that once the deoxidation has been effected, any addi-

* Abstract of a paper read at the Toronto meeting of the American Foundrymen's Association, June, 1908.

tional titanium added is partially wasted. Hence, for ordinary foundry practice, 0.05 titanium added will be practically sufficient, larger amounts only being necessary in exceptionally bad cases or for special work.

A further curious fact in connection with the use of titanium in the foundry is the lessening of the chilling action. And yet whatever chill may remain shows very much harder iron. This is important in car wheel work. Test pieces made in the Keystone Car Wheel Works with iron which chilled 1½ in. deep, when treated with titanium in the ladle gave but 1 in. chill. Prisms cut from these chilled portions, the castings having been made from the same metal, when subjected to compressive strain and also tested for hardness with Brinell's test (use of diamond) gave the following results :— The original iron crushed at 173,000 lb. per square inch and stood 445 in the test for hardness, soft steel running about 105. The treated piece ran 298,002 lb. per square inch, and showed a hardness of 557. Testing the soft metal below the chilled portion for hardness gave 332 for the original and 322 for the treated piece, or practically the same material so far as hardness was concerned.

The Remelting of Titanium Iron.

The writer wishes to call attention to another curious phenomenon in connection with these tests. In order to see what effect the remelting of a titanium pig-iron would exhibit, a special batch made in the electric furnace, containing 3.14 titanium and 5.78 graphite, was run through the cupola. The product was cast into test bars the usual way, and part of one ladle into a chill cup. The metal as it came from the electric furnace originally was so tough that it could be broken only with severe exertion. Much of this strength was lost in the cupola remelt, and the composition of the bars was as follows :—

Silicon ...	... 0.97	Graphite ...	... 3.18
Sulphur ...	... 0.067	Total carbon	... 3.94
Phosphorus	... 0.064	Titanium ...	... 0.72
Manganese	... 0.27		

The bars were dark grey, where one would expect a heavily mottled or at least only very light shade of grey to exist, considering the composition and comparatively small diameter. It was noticed, however, that the bars when cast retained their red heat at least three times as long as ordinarily, and this opportunity for graphite to form may account for the dark grey fracture.

Now, the further curious fact with this experiment was seen in the chill piece cast from the same ladle as some of the bars. The metal set in such a way that a large excrescence was forced out at the top. Further, when the chill piece was broken the fracture showed distinctly the cross of St. Andrew in its crystallisation. Incidentally, the graphite of the chilled piece was 0.05 per cent., the other constituents being practically the ones given.

Just what may be the true explanation for this must be left for future investigation, but perhaps some light may be thrown upon the subject by the following :—Experiments made by Mr. Fitzgerald at Niagara Falls in treating molten iron with 1 per cent. titanium, the bath of metal being 2,300 degrees F., showed that the addition in question raised the temperature some 25 degrees for a minute; it then slowly dropped to the original again. Evidently there was a reaction involving the giving out of heat. Possibly this may account for the long continued redness of the test bars cast in dry sand moulds.

Further, it is well known that a burnt heat causes badly "skulled" ladles, the slight drop in temperature of what looks like highly overheated metal being sufficient to do this. Here is a case of raising the melting point of the metal through oxidation. Possibly, by the addition of titanium and the consequent removal of this oxidation, or even of absorbed nitrogen, more particularly noticeable in steel work, the melting point is dropped again, and longer continued fluidity gives rise to the phenomenon above described.

While this cleansing action of titanium is exceedingly interesting to the ironfounder, the producer of copper is really far more concerned. Titanium copper alloy, when added to molten copper, deoxidises it so rapidly that it is perfectly possible to make absolutely sound copper castings with a very small addition of titanium.

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MORRISON, INGRAM & COMPANY, LIMITED, ironfounders and engineers, Hygeia Works, Hadfield Street, Cornbrook, and Trafford Park, Manchester, have disposed of their Midway Works, and in future will concentrate their business at the Hygeia Works.

CHEMICAL REACTION IN FOUNDRY CUPOLA PRACTICE.*

By Jules de Clercy.

Mr. de Clercy in this paper dealt at some length with the subject, giving a comparison of cupola reactions with those of gas producers and blast furnaces. In conclusion, he summarised the conditions most suitable for the proper operation of a cupola, as follows :—

1. Distribute the blast through several rows of tuyeres, with a view to securing as complete and perfect a combustion as possible of the carbon and of the combustible gases; keeping an even temperature throughout the entire melting zone, taking care to make the cross-section of the upper tuyeres much smaller than that of the lower ones, so as to avoid sending an excess of air into the upper strata of the melting zone.

2. See that the position of these tuyeres varies according to the nature of the fuel, according to its degree of average humidity, and according to its size, always bearing in mind at the same time that any fuel will always act with regard to the blast in the same manner as if it were all composed of pieces of the smallest size it contains; also, that anthracite and dense cokes will have a deoxidising power considerably inferior to that of light porous cokes.

3. It will always be advisable to mix in with the blast a stated amount of gases subject to being deoxidised by carbon at a high temperature, such as steam or carbonic gas. This will prevent the temperatures becoming excessive at points where the combustion is most active, and so preclude the possibility of burning the iron. It will also transfer any excess of heat existing around the lower row of tuyeres to the upper strata of the melting zone, and in particular to that part of the fuel bed immediately in contact with the metal. As to the manner in which these auxiliary gases are to be procured, it is one of extreme simplicity, for all that is required is to draw them off from the upper part of the cupola itself, just beneath the level of the charging door, where they are drawn off by means of an apparatus specially designed so as not to develop excessive temperatures in the blast piping. The result of this is to mix with the air of the blast not only the carbonic gas resulting from the combustion of the coke and the steam coming from the humidity carried by the fuel but also a portion of the carbon-monoxide, which is just so much more fuel saved, as well as a certain amount of B.t.u.s. (one B.t.u. equals a quantity of heat sufficient to raise the temperature of one pound of water one degree Fahr.), furnished by the apparent heat of all the gases.

These processes and reactions were turned to practical use by Mr. A. Baillot, and so far the results obtained by him, both in Europe and in America, in the various applications he has made of them have been highly satisfactory. As much as 15 lbs. of iron have been turned out per lb. of coke, bed included, and the iron has always been found to be of quite a superior quality. In fact, Mr. Baillot has realised in actual practice all the desirable advantages enumerated above and, at the same time, secured greater speed of melting and increased capacity of cupolas for a given size than was heretofore possible.

* Presented at the Toronto Meeting of the American Foundrymen's Association.

FERRO-ALLOYS IN THE FOUNDRY.*

By W. M. Saunders.

The manufacturer of steel has found that the addition of certain metals endows the steel with properties it did not before possess.

The foundry metallurgist, observing this valuable addition to steel, naturally turned to the same metals for improving cast-iron.

Most of the metals employed melt at a higher temperature than cast-iron, and consequently do not react to the best advantage with the iron. This difficulty has been overcome by first making an alloy of iron and the metal, which melts at a lower temperature and easily diffuses throughout the cast-iron.

The importance of manganese to the steelmaker cannot be readily estimated.

The ferro-manganese known as spiegeleisen, used by Bessemer in his work, contained from 10 to 15 per cent. of manganese, and was made in the blast furnace. To-day, ferro-manganese can be obtained containing 80 to 85 per cent. manganese.

Some years ago, about 1886, R. A. Hadfield discovered that steel with 1½ per cent. manganese became brittle. Between 5 and 7 per cent. manganese it became very brittle. With the addition of manganese above this amount, the steel began to lose the property of

* Abstract of a paper presented at the Toronto meeting of the American Foundrymen's Association.

brittleness, and assumed that of toughness and hardness. These qualities greatly increased in the presence of a certain amount of carbon and the proper heat treatment, until the steel contained about 12 per cent. manganese, when it became exceedingly tough and hard. This material was known as Hadfield steel.

The effect of manganese upon cast-iron resembles in many ways that upon steel.

High manganese castings are employed only in special cases where exceptional hardness is desired. Castings with 1 to 1½ per cent. manganese are sometimes made, but the best results are obtained in grey iron with manganese under 1 per cent.

Manganese in Cast-Iron.

Ferro-manganese in the foundry has an important part to play in perfecting cast-iron. It has been claimed that ferro-manganese makes hard iron soft, and soft iron hard. This anomaly is not difficult to explain. Cast-iron with a low percentage of manganese often gives trouble in machining, by causing the drills or tools to become dull. This trouble at once disappears upon adding enough ferro-manganese to bring the manganese to 0.5 per cent. High manganese pig-iron added to the charge in the cupola will also give the same result.

Manganese reduces the tendency of cast-iron to chill, and consequently when ferro-manganese is added in small quantities in the ladle, the iron becomes softened.

A cast-iron may contain the requisite amount of manganese for good machining, but it is necessary to make the iron hard and tough for cylinder purposes. With the addition of enough ferro-manganese to raise the manganese to 1 per cent. or over, the desired hardness is produced.

Silicon.

Ferro-silicon containing silicon up to 20 per cent. is a product of the blast-furnace, and is extensively used in the foundry as a "softener." With the event of the electrical furnace ferro-silicon containing as high as 75 per cent. silicon became possible. That having 50 per cent. silicon is probably the most desirable to use in the iron foundry, on account of its lower melting point.

Ferro-silicon is used in steel-making as a deoxidiser. A small percentage of silicon in a steel greatly increases the elastic limit and tenacity. A further addition causes the steel to become weak. until at about 4 per cent. silicon it is very brittle and hard.

Cast-iron with 4 per cent. silicon also shows weakness, but not as marked as in steel. As the silicon in cast-iron increases above 4 per cent. the hardness and brittleness become very apparent.

Overheated iron in an air furnace often may be restored to the right condition upon adding a sufficient amount of ferro-silicon; the silicon deoxidises the iron, leaving it in the proper state for good casting.

Silico-Manganese.

Silico-manganese, containing from 35 to 70 per cent. of manganese, and 20 to 25 per cent. silicon, the remainder chiefly iron, is sometimes used to raise both the silicon and manganese in cast-iron; its action being similar to a mixture of ferro-silicon and ferro-manganese. In steel-making it is employed as a deoxidiser.

Aluminium.

Aluminium is used in the manufacture of steel for the purpose of assisting in the formation of sound ingots; little or none of the metal enters into the composition of the product. When an increased amount of aluminium is added, a part alloys with the steel and the effect in small amounts is similar to that of silicon. Either the metal or ferro-aluminium containing 5 to 20 per cent. aluminium may be employed.

In cast iron the influence of aluminium resembles in many ways that of silicon. A white cast iron to which ½ to 1 per cent. aluminium has been added assumes at once the appearance of grey iron.

Phosphorus.

Ferro-phosphorus is made containing from 20 to 25 per cent. phosphorus. In steel-making it is used to increase the phosphorus in basic slag for certain purposes, and also to add phosphorus to steel used in making thin rolled plates.

In the foundry ferro-phosphorus is employed to increase the phosphorus in cast iron in the ladle, when it is desired to prolong the time of fluidity, as in the case of very thin castings.

Cast iron containing about 1½ per cent. phosphorus causes the tools used in machining it to become heated and quickly worn, while with 2 per cent. and over cast iron becomes brittle and weak.

Phosphorus under 1 per cent. in general machinery castings is desirable, and in some cases as low as 0.2 per cent. is necessary to secure strong iron.

Titanium.

Ferro-titanium is made containing 10 to 30 per cent. titanium.

In the form of a ferro-alloy, and also as titanium thermit, titanium is used in small amounts in steel-making and in the iron foundry to remove gases absorbed by the molten metal. The action is purely chemical, the titanium combining with oxygen forming oxides, and with nitrogen forming nitrides of titanium, the resulting compounds being found in the slag; none of the titanium enters into the iron, which remains soft. With larger additions of the alloy, a small percentage of titanium unites with the iron, tending to harden it.

Vanadium.

Ferro-vanadium can be obtained containing from 10 to 50 per cent. vanadium. Small amounts of vanadium added to steel not only increase the tensile strength without making the steel hard but prolong its ability to withstand shocks and fatigue. One action of vanadium is probably similar to silicon and aluminium: removing the oxygen and oxides, thus leaving the steel in a purified condition. A small amount of vanadium will be found in the steel, and it is very likely has an influence upon the carbon present, which in turn imparts its properties.

Nickel.

The introduction of 3 to 3½ per cent. nickel in steel causes an increase of about 30 per cent. in tensile strength, and fully 75 per cent. in the elastic limit, without apparently changing the elongation. Further addition affects the hardness until with 16 to 18 per cent. nickel the steel becomes exceedingly hard and difficult to machine. Upon increasing the nickel contents above this point the material becomes soft. The hardening action of nickel upon steel is probably due to its effect upon the carbon. Cast iron with 30 per cent. nickel is not easily corroded by water or exposure to the usual atmospheric conditions.

Chromium, Tungsten and Molybdenum.

These metals alone or in form of ferro-alloys have but little influence upon cast iron. In steel, however, they have an important place to fill. Chromium is used in projectiles and tool steel for its hardening properties. Tungsten and molybdenum are employed chiefly in the manufacture of tool or self-hardening steel.

ANNEALING CASTINGS.*

By W. M. Carr.

Annealing methods in the foundry industry are recognised as established practices.

In the manufacture of chilled cast-iron car wheels no dispute exists regarding their treatment in annealing pits. They would never be shipped or put into service without such treatment. The value of the treatment is fully recognised, and receives as much attention and care as any step in their manufacture.

In the production of grey iron castings annealing is sometimes followed with a view to lessening certain stresses or strains set up in the cooling of the castings from the pouring temperature. The influence of the process in the case of grey iron upon the formation of the carbon compounds is not so important. If, however, changes should occur, they would be in the direction of softening the surface of the castings.

In the three branches of the foundry industry just cited, annealing is followed in the first instance primarily to change the formation of the carbon compounds from a hard, glass-like carbide of iron to the temper carbon, a substance not unlike graphite in its characteristics, conferring softness and malleability by certain methods of heat treatment upon a previously hard, brittle substance. In the second case, annealing lessens intense cooling strains in the plate and other parts of the wheel, but does not so affect the carbon compounds as to damage the depth and hardness of the chilled tread, throat and flange. In the third instance, annealing concerns mainly the avoidance of cooling strains.

Coming to the steel-casting industry we have a very important one in which annealing is open to some doubt. It may be the practice or it may not. That it has some value is a settled fact, but is not generally so recognised. When specifications so demand steel castings are put through an annealing furnace, frequently without any consideration as to the conditions of time and temperature. In the absence of annealing specifications steel castings are frequently shipped without such treatment.

Here we have the paradox of pains taken in the selection of raw materials, watchful manipulation of the melting and

* Abstract of Paper presented at the Toronto meeting of the American Foundrymen's Association.

refining process in converting pig-iron and steel scrap of proper quality into steel, pouring it into moulds of particularly refractory sand, stripping and cleaning followed by rigid inspection for flaws and imperfections outwardly visible, and finally shipping to customer without annealing, delivering the casting with unknown stresses present, coarse, internal structure and other variables more or less liable to vitiate the value of the castings in service.

I do not mean to say that annealing will make the casting infallible, but I do know with other conditions being equal that an annealed casting is less liable to fail in service than one not annealed.

In annealing steel castings we have conditions that are not entirely comparable with conditions existing in other branches of the foundry industry where annealing is more or less essential. The operation is not concerned with the changes in the carbon compounds. That is to say, the same carbide of iron will be present both before and after the treatment. In the matter of internal structures there are mainly two components; first, the crystalline formation and its refinement resulting from proper thermal treatment; and secondly, the removal or lessening of internal stresses set up in cooling down from the casting temperature.

The refining temperatures are not the same for all metals, but generally speaking a suitable temperature to grain refine cast steel is about 825 to 850 degrees C.

There are, however, practical considerations to take into account that cannot be determined entirely by laboratory tests, such as the length of time to anneal a casting of a given shape and size, and the style and type of furnace best suited to certain requirements. These points are capable of determination through the character of product and probable tonnage.

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THE English rights in Tilson's patent forced-lubrication system have been acquired by Vickers, Sons & Maxim, Limited.

CAMMELL, LAIRD & COMPANY, LIMITED, are negotiating with the Cunard Company with reference to the undertaking by the former company of the repair work which may be required for either of the giant Cunarders.

AUTOMOBILE CYLINDER MANUFACTURE.*

By L. N. PERRAULT.

THE automobile has undoubtedly done more than anything else to develop the highest degree of skill and accuracy in the foundry. The successful making of the various types of cylinders demands the utmost painstaking, intelligent forethought and supervision.

A thorough knowledge of the subject, which can be acquired only by long experience, is indispensable to the foundryman who hopes to make a success of casting water-cooled cylinders with the jackets integral. With the most skilfully-made patterns and core boxes it is often necessary to make slight alterations after the cylinder is cast, and it seems almost wonderful that the patternmaker can work as closely to the many curves and odd shapes as he does, and not vary more in the thickness of the metal walls.

Take for illustration, the twin cylinder unit in common use. In some patterns the entire core, with the exception of the barrel cores, and consisting of the top and bottom jackets, two ports, one inlet and one exhaust core, are assembled and pasted in a form (which may be made of iron, plaster of Paris, or oil sand, and which is an exact replica of the bottom of the mould), then dried in the oven, and, when ready, set into the mould as one core. In this case one can readily see the necessity of each core having suitable provision made for locating and locking into exact place, for the variation of even 1-64 in. in one core only would cause the casting to be scrapped. In other patterns of the same outward design, the bottom jacket is first located in the mould; next the barrel cores, which in this case have port and valve seat cores made integral with them, are set. Then the second section of the jacket core is pasted in place, and the first cheek closed; next, the inlet and exhaust cores are set in place and the top jacket pasted on and dried in the mould with a gasoline torch, and the second cheek and cope closed and clamped ready to cast. Either method is reasonably safe, but the writer prefers the second, as one has the opportunity to see that the cores are properly located after each operation. On this work it is very necessary to have just

* Abstract of a paper read at the Toronto meeting of the American Foundrymen's Association, June, 1908.

the right materials for making both the mould and cores.

Thin Cylinder Walls.

The great stress laid by the automobile engineer upon saving weight has made thin castings a necessity in cylinders with the water jackets cast integral. Little by little the thickness was reduced until the danger line was reached. Then strengthening ribs were added, and these coming in the jacket core boxes make the problem all the more difficult for the foundryman. Again, the presence of bosses for the various studs, etc., often necessitates the use of internal chills to hasten cooling and prevent shrinkage. The enormous strains put upon the cylinders in actual service, by reason of vibration, and the unequal heating of different parts by the exploded gases, make the question of strength an important one. Strong irons, by reason of their chemical composition, are inclined to be rather hard when cast into such thin sections, yet the engineer demands a strong casting, which must machine uniformly and be absolutely free from either hard or spongy spots and sound in bosses and jackets.

Analyses of Mixtures.

As the result of careful study and patient experiment, the writer has settled on a mixture which has stood the test of time, and has been uniformly satisfactory, giving a tensile strength of about 36,000 lbs. per square inch. Strange and complex are the opinions of some of the designers. As an illustration is given herewith analyses of two castings preferred by different men :—

	French.	English.
Silicon	1.7	2.73
Sulphur	0.110	0.083
Phosphorus	1.10	1.141
Manganese	0.500	0.41

Moulding.

When the size of the order will permit, interchangeable iron flasks should be used. These should be as light as is consistent with safety, for in three or four parted work the handling of flasks is quite an item in the moulder's labour. The patterns and core boxes should be of metal, or if of wood the parts most exposed to wear should be protected by metal facing. All loose bosses, etc., should be so fitted that even the slightest displacement cannot occur, and such bosses as will permit of it should be cored to avoid shrinkage, for every part of the cylinder must be tight to stand the strains of service. The sand should be of fine texture and open-grained, very carefully mixed or ground, worked rather dry, and well blackened with a good grade of plumbago. These points if carefully observed should produce smooth, round castings in green sand. The following methods of moulding are used in our foundry, the selection being governed by the type of pattern, size of order, etc. :—

1. In this case one moulder makes and casts his work.

2. The different parts of the pattern are fastened to mould-boards. Skilled moulders are used on the difficult parts, and cheaper men on the simpler parts, while the coring, closing, etc., are done by another gang, and the moulds cast by labourers.

3. The patterns are mounted on moulding machines operated all day by one gang, while the core setting, casting, etc., are done by others.

The writer has in his mind a certain cylinder, for several years moulded by the first method at a cost per cylinder of 66 2-3 cents. each. Later, it was made on a three-parted moulding machine at a cost of 16 cents., while there was a saving in cost in machine shop of 25 per cent. over the old method of hand moulding.

Coremaking.

Iron forms should be provided for such cores as need support while drying, others also for shaping the core wires. These can be made by a boy or labourer and stored till wanted. The sand should be strong, sharp, and sufficiently fine to give a smooth surface. We prefer an oil-binder for various reasons. The wax vents must be of a composition which will neither flatten out nor break under the rammer, will melt readily in the oven and be absorbed by the sand with no detriment to the core. Some wax leaves the core rotten about the vents and is liable to give way to the pressure of the iron while being cast, causing the loss of the cylinder.

The wires should be pliable, yet strong enough to hold their shape when set, and should be led to all parts of the core in a manner which will permit their ready removal after casting. They are not only necessary for support, but they assist greatly in the removal of the core, which becomes somewhat loosened by their withdrawal and flows through

in their wake. After drawing off the box, all jacket cores should be carefully examined for exposed wires or vents, and these attended to before the cores are placed in the oven. After being dried, the cores should be well blackened and again dried, and if they are to be assembled and pasted by the core-maker should be accurately measured by the proper forms and gauges and set aside ready for the mould.

Each foundry should have its own wax-vent machine, with dies for the various sizes needed. One man by two hours' work with this machine can turn out vents enough to supply a hundred core-makers.

Pouring the Casting.

The iron should be melted "hot" and handled as quickly as possible to avoid cold shuts in the jackets, also because a casting poured hot is more likely to finish sound than one poured dull. With good sized pouring basins and risers where needed, hot iron of the right mixture, sound cores and a well-made mould, the losses on this class of work will be about the usual foundry average.

Cleaning.

We prefer to pickle our castings; first, because there is less risk of breakage than in tumbling; second, because pickling softens the skin or scale, which otherwise is hard on the cutting tools, and, lastly, because dirty spots or other blemishes are more apt to be readily found than in a black polished surface. Our method is as follows:—The gates, risers, and fins are first removed. Next the wires are drawn out and the casting is lightly tapped with a hammer and rolled from side to side on a plank, bringing each cored hole in turn to the bottom so that the core sand may flow freely out. Then at last by running a wire from the cored hole to all the remote places, we make sure that all the sand is out. The casting then goes to the pickling bench, is well drenched, and left till the following morning, when it is washed and goes to the inspector. He carefully looks it over for outward defects, and if none are apparent he measures it with the proper gauges and sets it aside to be chipped and filed. The castings are next subjected to a hydrostatic pressure of 100 lbs. to ascertain if there are any leaks from the water jacket, both externally and internally. This done, if good they are ready for shipment.

COPPER ALLOYS FOR STEAM VALVES AND FITTINGS.*

By G. K. Elliott.

The dependence of the steam engineer on the metallurgist is heavier than the former suspects, and at no point is this truer than with respect to valves. An undependable and fickle steam valve is about as awkward a source of annoyance as there can be around the boiler-room. The operation of a whole plant often hangs upon the good behaviour of one or more small valves.

To the metallurgist and foundryman, steam valves have problems peculiar to themselves, and a sound, flawless pressure-tight valve of strong, steam-enduring metal represents on of the highest grades of scientific metallurgy and foundry practice.

There are two general classes of steam valves, those made of copper alloys and those of iron. On account of time limitation we shall consider only the former.

Copper.

Pure copper is a malleable, ductile metal, melting at 1,983 degrees Fahr. It has a tensile strength, when cast, of about 18,000 lbs. per square inch. Its fracture when freshly broken is silky and of a mild salmon colour. It is also tough and tenacious, and therefore quite difficult to machine.

At first study, pure copper would seem an excellent valve metal. It has a much higher melting point than its alloys and is fairly strong. The expedient has been tried by some valve-makers of making valve discs from pure copper, but they have not been successful, as constant exposure to steam wrought a physical change in the copper, whose structure became coarsely crystalline, and even surface cracks at times developed. So copper in an unalloyed form is out of the question.

The points to be considered by the metallurgist who is to evolve a good "steam metal" are, first of all, resistance to the wear of steam, then strength and adaptability to casting, and, lastly, ease of machining.

Copper and Tin.

Our problem is to take copper with its softness, weakness, and toughness, and

* Abstract of an address delivered April 25, 1908, before the Associated Foundry Foremen in Cincinnati.

by judicious alloying give it the above qualities.

Hardness and strength would both result from an alliance of copper with tin, forming what are known as the "bronzes." Tin itself is soft, ductile, and quite weak—about 3,300 lbs. tensile strength to the square inch—but when alloyed with copper it forms certain crystals with that metal which are very hard and brittle, but evidently of some considerable strength when exposed to gradual strains radially applied. These crystals of hard $SnCu_3$ and $SnCu_4$ scattered through the alloy help to give it hardness and strength. Six to ten per cent. of tin will about double the strength of copper. Moreover, these bronzes are quite resistive to the ravages of steam. Tin is the life-giving element in a steam metal.

Our steam metal would now be complete were it not for manufacturing troubles. In the first place, copper and tin alloys are extremely hard to cast, especially if the castings have to be pressure-tight. Blow-holes, tin spots and oxide spots are common defects. The medicine for this is zinc—zinc which claims a greater affinity for the trouble-bringing oxygen than does copper or tin. Zinc deoxidises or cleans out the metal, and perfect castings are possible. It was for this reason that the old gun-metal formula of 90 per cent. copper and 10 tin now reads: copper 88, tin 10, zinc 2.

Lead.

Often it is necessary to make our "steam metal" somewhat softer so as to reduce the cost of machining. This is readily done by the addition of lead. Lead, however, must be handled with care, as a very small excess while making an easily machinable metal, will utterly ruin it for service on modern high temperature and pressure steam lines. Over 2 per cent. lead seriously affects a valve and lays it open to the "wire drawing" action of live steam.

The virtue of a steam valve, therefore, depends upon sufficiently high content of tin and a minimum amount of lead. These are two sore points of temptation to the "economising" producer. Tin is the highest-priced of these metals and lead about the cheapest. Tin also increases the cost of machining, while lead reduces it wonderfully. The cheaper grades of bronze valves invariably are lacking in tin and overdosed with lead and zinc.

Steam Metal.

A good bronze of this sort usually has a tensile strength of about 34,000 lbs. However let this same alloy, according to chemical analysis, be poured at temperatures that are too high or too low, and the alloy may show only 24,000 lbs. tensile strength. Or let the furnace work badly or lag, so that an unwonted length of time is consumed in melting and in reaching the pouring temperature, and we will have a poor casting in spite of the excellent mixture of metals that was used.

The Use of the Pyrometer.

In the Lunkenheimer foundries it has been found absolutely necessary to make constant use of the pyrometer. This instrument is used not only to determine when the metal is at the proper pouring temperature, but also to watch the furnaces during the progress of every heat to see that they are working at their maximum speed of heating, thus always insuring rapid heats and clean unoxidised metal. The proper heat treatment is as important as the proper composition, and, notwithstanding, it is an almost universally neglected point in the majority of foundries, at least so far as scientific methods of temperature measurement are concerned.

Moulding Sand.

Moulding sand is quite sensitive to changes in the humidity of the atmosphere, and often the moulder works it wetter than he thinks. This is the direct cause of many bad castings. It has been found profitable in the Lunkenheimer foundries to have actual laboratory tests for moisture in the sand made each day and the moulders instructed accordingly as to how much water is to be added to the sand.

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BROOK, HIRST & COMPANY, LIMITED, Chester; Henry Berry & Company, Limited, Leeds; and Messrs. A. Bolton & Company, Manchester, have appointed Mr. E. H. Judd, Grosvenor Buildings, Glasgow, their sole agent in Scotland.

JAMES HOWDEN & COMPANY, LIMITED, of Glasgow, have secured the contract for a 6,000-kw. Zoelly turbine with alternator and condensing plant for the Manchester Corporation. Messrs. Howden are now proceeding to greatly enlarge their works in Glasgow to prepare for the rapid production of these turbines of all sizes.

The "Foundry Trade Journal" Bookshelf.

American Foundry Practice.

By Thomas D. West.

It has been claimed that the most competent writer on foundry practice would be a practical foundry-foreman, with a good technical and scientific knowledge. In that respect this book should be a very useful one to the trade, for the author has been both a practical moulder and a foundry manager, as well as being a member of several technical associations. He treats in this work with loam, dry-sand and green-sand moulding, and follows with a treatise on the management of cupolas and the melting of iron. The object is to place in the hands of the foundryman a practical work of reference which will assist him in manipulating intricate jobs and making difficult castings. Accordingly, after opening with a chapter or two of sound advice on the trade and the foundry, the author proceeds to deal with different pieces of work in green-sand moulding. The descriptions are essentially practical and full of detail, such as would assist the moulder at work, and to aid the descriptions there are detailed drawings by the author.

The subjects treated in the section dealing with green-sand moulding include the moulding and casting of flywheels, large and small pulleys, moulding bevel and spur wheels without a pattern, improvements in moulding gear wheels, pulleys, etc., finishing the moulds, venting the moulds, moulding kettles with a dry-sand cope and green-sand bottom, moulding kettles in green-sand without a pattern, elbow and branch pipe moulding without patterns, large pipe-work, heavy green-sand casting, and other matters. The author deals with his subjects in the easy manner of one accustomed to the moulding floor and the ways and vagaries of the worker. He takes the piece of work through its various stages, explaining the necessary points and illustrating the causes of failure in a manner that holds the reader's interest. Coming to loam and dry-sand moulding, the building and firing of large drying ovens is first dealt with, after which ovens for drying small cores are considered. Short articles on moulding crooked pipes and large quarter-turn pipes in loam open the descriptions of loam practice, followed with the particulars for moulding kettles. As an example of heavy work, casting anvil blocks is taken, the procedure being described and illustrated. Other work dealt with includes sweeping an octagonal mould, moulding rolls and making flasks, moulding gear wheels in dry-sand or with cores, and making return, elbow, branch, and T-pipe core arbors. After giving some advice on the laying of bricks for loam moulds, he deals in a series of short articles, with such subjects as the venting and drying of moulds, making hay-rope loam cores, blacking and sleeking loam and dry-sand moulds, chaplets and their use, reservoirs and ladles for pouring heavy castings, and the scabbing of the different classes of moulds. A further section of the book concerns the manipulation of iron castings, and here are dealt with such questions as contraction and shrinkage in castings, the feeding and shrinkage of melted iron, straightening crooked castings, etc. One chapter graphically describes the method of burning on a new neck and wabbler to the end of a broken cast-iron roll. Though this particular piece of work is dealt with, the process is described in such a manner as to be applicable to the mending of all heavy castings. Chilled castings in iron moulds, and the making of such articles as pulleys, gear wheels, etc., that have to be split after casting, in turn come up for consideration, and the author then proceeds to deal with the mixing and melting of the iron. Following a chapter on the tuyeres and lining of a cupola, the preparing of cupolas is described. The important subject of charging fuel and iron is treated, followed by instruction on the topping out and stopping up of cupolas; and then comes a description of air furnaces for melting heavy bodies of scrap iron, and for melting iron for heavy castings. Information on loam, dry-sand and core-sand mixtures and green-sand facings, and tables giving the weights of castings complete the book. The author has adopted a manner of description which is attractive to the actual worker; he has avoided the stilted technical style of some writers, and has not disdained the use of anecdote and personal experience to lend interest to the instructions given. The book will be useful to both apprentice and foreman as a handy work of reference on everyday foundry practice. *The publishers in London are; Chapman & Hall, Limited.*

INSTITUTE OF METALS.

It was unanimously decided at a meeting held at the Institute of Mechanical Engineers, London, on June 10, to found the proposed Institute of Metals, particulars of which we have already published. Sir William White presided at the meeting. Mr. Johnson read letters from Messrs. Vickers, Sons & Maxim, Limited, the Royal Mail Steam Packet Company, the King's Norton Metal Company, Birmingham, Messrs. Harland & Wolff, Limited, Belfast, the Fairfield Engineering and Shipbuilding Company, Limited, Glasgow, Messrs. Yarrow & Company, Limited, Glasgow, Messrs. Cammell, Laird & Company, Limited, Messrs. George Clark, Limited, engineers, Sunderland, Messrs. Workman, Clark & Company, Limited, Belfast, Professor Hofman, and others approving heartily of the proposed formation of the Institute.

Sir William White complimented Mr. Johnson and Professor Carpenter on the success that had so far rewarded their efforts in the preliminary work of founding a society which was greatly needed. Such an institution, he said, would extend knowledge in regard to non-ferrous metals and alloys, and would establish a means of communication between members of those trades directly interested. It was proposed to exclude the question of wages and points in regard to labour. Periodical meetings would be held to discuss matters of interest and importance to manufacturers who used non-ferrous metals; they meant to exclude all reference to iron. The Institute of Mechanical Engineers had made an endeavour in the past to assist the engineer in regard to the use of alloys in non-ferrous metal, and he wanted to assure those who were desirous of forming the Institute of Metals that they would have the hearty support of the Council of the Mechanical Engineers' Institute. The new Society would take up the work hitherto done by the older Institution, and would not be regarded in any sense as a trespasser. The Mining and Metallurgical Institute would also extend them the hand of welcome. The truth was that as knowledge increased it became absolutely necessary to create separate societies, and the institutions he had mentioned recognised that fact.

So far (Sir W. White continued) there had only been one contentious point raised in connection with the founding of the Society, and that was the bearing the Institute might have on what were called trade secrets. There was one sufficient statement which might be made to such an objection; the members would be allowed to exercise their individual right in regard to showing members of the Institute over their works, and they could, of course, personally determine how far they would participate in the discussions which would be arranged. There was room enough for serious and valuable work without touching upon disputable points where they were likely to prejudice the interests of individual members. He moved: "That in view of the widely recognised need for a medium of communication for the advancement of knowledge in connection with the production, manufacture and use of non-ferrous metals, a society to be called the Institute of Metals shall be, and is, hereby started."

Sir Fortescue Flannery, who seconded this, said that during the last thirty years separate specialised societies had done great work in the spreading of scientific knowledge. There were thousands of scientific men in the country to-day who had been educated and had risen up under the auspices of such scientific societies.

Mr. Thomas Bolton explained that he appreciated the value of having a little up one's sleeve, and therefore if the members were permitted to join on the understanding that they could preserve their trade secrets he would gladly support the proposed Institute.

Mr. Seaton advocated interchange of ideas, and considered that the manufacturer who did not benefit by receiving visits from competitors was sadly lacking in some respects. (Laughter.)

Mr. T. Mitton said the problems to be solved were too great for one man's mind, and it was only by co-operation that solutions could be found.

Professor Turner pointed out that an Institute of Metals would be of great service to Birmingham, where there were 40,000 people engaged in the brass trade and 30,000 employed in the manufacture of jewellery.

Interim Council.

The resolution was carried unanimously, and on the proposition of Mr. Harbord, the following interim Council was appointed:—Sir William White (President), Professor Gowland and Professor Turner (science), Mr. J. T. Milton and Vice-Admiral Oram (marine engineering), Dr. F. Elgar, Mr. A. F. Yarrow, and

Mr. G. B. Hunter (shipbuilding), Mr. Odo Vivian (copper), Mr. L. Summer (copper), Mr. J. D. Bonnor (British aluminium), Mr. Ristori (aluminium), Mr. C. A. Baeddicker (nickel), Mr. Norman Cookson (lead and antimony), Mr. G. W. Nisbet, and Mr. R. Kaye Gray (cables), Mr. J. A. Bayliss (Birmingham trades), Mr. Williams harvey (tin), Mr. Hurry Riches (locomotive engineering), Mr. Cecil Wilson (Sheffield smelting and precious metals), Mr. Ralph Heaton (Birmingham Mint), and Mr. Corfield (spelter). Professor H. C. H. Carpenter and Mr. W. T. Johnson were appointed Joint Secretaries

The annual subscription was fixed at £2 2s., with no entrance fee at the outset.

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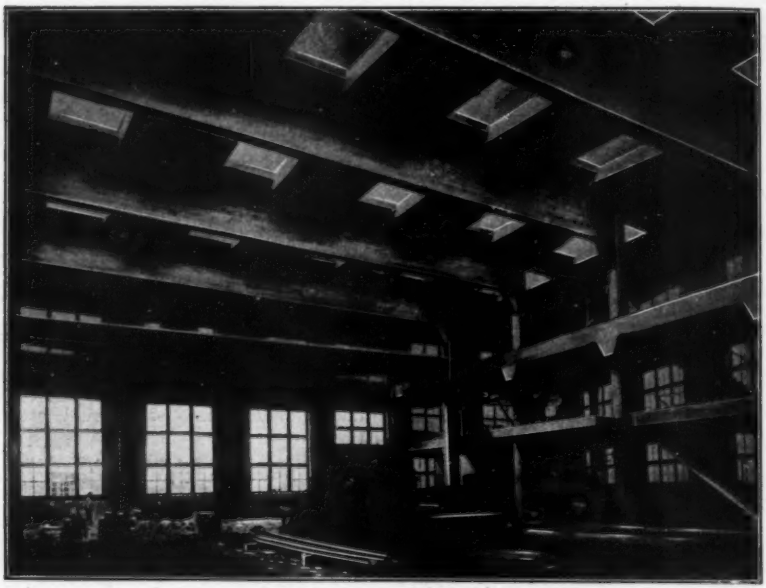
Messrs. Marshall, Sons & Company, Limited, of the Britannia Iron Works, Gainsborough, are represented at the show of the Royal Agricultural Society, at Newcastle-on-Tyne, by a block of shedding, with 100 ft. frontage, containing an extensive collection of their machinery.

REINFORCED CONCRETE CONSTRUCTION FOR THE FOUNDRY.

An interesting example of reinforced concrete construction has recently been completed by the Trussed Concrete Steel Company, Detroit, for Williams, White & Company, Moline, Ill. The building is designed for use as a foundry. It occupies an irregular area 133 ft. 3 in. by 120 ft. 6 in. in extreme dimensions. The building is so designed that practically the entire enclosed space is unobstructed by internal columns. But seven columns in all are used in the building, these being arranged along the longest side and quite close to one wall, as shown in the illustration. The roof is flat and composed of a 4-in. slab of concrete, 40 per cent. of the area being replaced with skylights, each of which is 7 ft. by 18 ft.



Interior of a Concrete Foundry Building.

The building was constructed on the Kahn system, and is especially interesting on account of the long span of the main girders, and also on account of the fact that it was impossible to make these girders continuous. This fact rendered it necessary that the diagonal or shear members of the reinforcing should be rigidly

attached to the main horizontal reinforcement. In this particular case one of the special features of the Kahn system was utilised; rigid attachment was secured by riveting angles and flats to obtained the desired reinforcement.

There are five of these girders, each with a clear span of 74 ft. 8 in. Between the girders, which are placed approximately 20 ft. centres, extend 10 in. by 16 in. beams placed along either side of all the skylights. The main roof girders are 78 in. deep, including the 4-in. roof slab, and 16 in. and 28 in. wide at the bottom and top respectively, the increased width in the upper part being necessary to provide ample compression area. The unobstructed space is 78 ft. by 123 ft.

The crane shown in the illustration was supplied by Niles-Bement-Pond Company, and has a clear span of 73 ft., centre to centre of rails, and a capacity of 15 tons. The rails are carried on 18 in. by 3. in. girders reinforced with Kahn bars. These girders rest on brackets made integral with the columns, as shown in the illustration.

An Australian Foundry.

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A meeting of the creditors of Mr. W. R. Mansell, of the Wrekin Foundry, Wellington, was held recently. The gross liabilities were put at £8,741 16s.; creditors fully secured, £7,120; assets estimated to produce £1,620. Mr. F. Cariss was appointed trustee of the estate.

AN AUSTRALIAN FOUNDRY.

A well-known firm in the stove-making business in Australia is that of Messrs. G. Fletcher & Son, Sydney. The firm has been engaged in the industry for nearly half a century, and it is calculated that upwards of 100,000 of their stoves are in use, in every part of Australasia.

The foundry and stove factory are located at Woollahra, where several acres of ground are under occupation, and in addition to the large moulding shops, machine and finishing shop, store rooms, furnaces, and iron yards, there are office accommodation, a grazing paddock, and stabling. When the business was started there 40 years ago, the place was little better than a wilderness upon the steep slope of a gully (known as Fletcher's Gully), branching from the valley that extends southward from the head of Double Bay. Great improvements have since been effected. Immense retaining walls have been built, and levelling and filling operations have transformed the rocky declivity into useful and easily accessible yards.

The business is not confined to stove-making, although that is a special line; it includes the manufacture of various forms of lighter cast- and wrought-iron work, such as balcony railings, friezes, ornamental gates, window guards, iron awnings, and verandah posts, iron staircases, both straight and spiral—in fact,

all kinds of architectural iron work, as well as railings for monumental work.

In the yards adjoining the foundry may be seen hundreds of tons of scrap and pig-iron, ready to be transformed or reformed into its new sphere of usefulness.

The metal is first collected in a ladle, having a capacity of nearly half a ton, whence it is poured into hand-ladles of various sizes, according to the nature of the work in hand. The furnace is operated by the aid of a patent Root's blower, which is controlled, like the rest of the machinery and apparatus throughout the establishment, by a 25-h.p. steam engine.

The machine shop is a large building about 120 ft. long by 70 ft. in width, and among the appliances in use, mostly power-driven, are sheet iron working machines, drilling machines, rollers, angle-benders, shearing machines and guillotines, emery wheels, and punching machines.

The stoves are made in a variety of sizes, ranging from 2 ft. to 12 ft. in length, and in weight from 2¼ cwt. up to a ton or more. The largest ranges will cook for 300 persons, and are installed in many of the leading hotels and restaurants of Sydney.

In the illustration shown herewith will be seen one view of the foundry.

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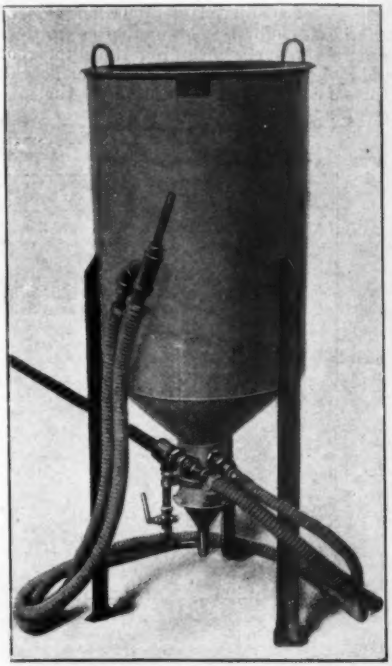
THE PATTERNMAKERS' ASSOCIATION.

THE monthly report for May, issued by the United Patternmakers' Association, states that the number of members is 6,939. The reports from the different districts as to the state of trade vary from very bad to fair or moderate, indicating a general depression. The Secretary states that the number of unemployed members has steadily increased during the month of May, and when the branch reports were sent in there were 1,275 members signing the vacant books, as compared with 1,212 at the end of April. This increase is accounted for by the additional members who have been thrown out of work on the North-East Coast, where no fewer than 411 members are out of work, or 38.2 per cent. of the total membership in that district, as compared with 361, who were unemployed at the end of April. On the Clyde the roll of idle members totals 341, or 25.2 per cent. of the Clyde membership; at the end of April the members out of work totalled 334.

THE LEIMAN SAND BLAST APPARATUS.

MOST foundries have use for a sand blast, either to clean sand from castings or patterns or to produce some style of finished surface on metals. A moderate-priced, compact apparatus for all classes of light or heavy work is illustrated here-



THE LEIMAN SAND BLAST APPARATUS.

with, as made by Leiman Brothers, Newark, N.J., U.S.A.

The nozzle of this new machine is a long, straight piece of ordinary iron pipe, and does not have the tapered hole used on other sand-blast nozzles, and, therefore, is less subject to wear. The air goes directly from the compressor to the mixing chamber at the base of the nozzle, the vacuum there created drawing the sand through the sand-feed pipe from the body of the machine. As the sand reaches the mixing chamber it receives the full pressure of the air to drive it through the nozzle, so that there is not the necessity of making the nozzle tapered to increase the velocity. In this way not

only can a larger nozzle be used, thereby covering a much larger surface with a given pressure of air, but it may be longer (even to the extent of several feet), enabling the operator to stand at a distance from his work with just as satisfactory results.

Since the air does not go through the body of the machine, the latter does not need to be of steel, and heavy galvanised iron answers the purpose. The sand is dried by heating, and is then simply thrown into a depressed sieve at the top of the machine, being then sifted automatically. The machine holds enough sand for three or four hours' continuous operating, and the 10-ft. double length of wire-covered rubber hose with which the machine is equipped makes it possible to operate the nozzle in any direction.

Leiman's rotary high-pressure blowers or any air compressor may be used with this machine. The sand-blast machine when mounted on a movable platform with a blower may be moved out of the way when not in use, and the sand-blasting room used for other purposes.—"Iron Age."

——o——

BRASS AND ITS ALLOYS.

In the course of a lecture on brass delivered by Professor T. Turner at Birmingham University, the lecturer observed that copper was the raw material in many of the Birmingham trades, and other metals were alloyed with it to give desired qualities, such as colour, strength, and working properties. The metals available were limited partly by price, but such a limit was variable. As a simple definition a common metal might be regarded as one which could be purchased at not more than half-a-crown a pound, and a rare metal as one that cost more than five shillings an ounce. Such a definition would include among the common metals in order of cost iron, lead, zinc, copper, nickel, aluminium, and tin; in an intermediate class would be bismuth, cadmium, calcium, magnesium, and silver; while gold would be classed among the rare metals. All the common metals, as above defined, were used in connection with the brass trade, while a variety of other metals and substances were also added to alloys for various purposes. Of these common metals three—namely, zinc, nickel, and aluminium—were not used by the ancients. Zinc was stated to have been met with in the ruins of Cameros, which was destroyed by the Romans about B.C. 500, but its discovery was attributed to the middle ages, as it was first described about 1530. It was obtained from China and India until about 1721, when the manufacture was introduced into England. The modern process was developed in Belgium and Silesia about a century ago, there being two modifications of the same essential ideas. Europe still led the way in zinc manufacture, and Great Britain raised a considerable quantity of zinc ore, but the United States was rapidly developing its zinc production. The purest kind of zinc was redistilled; then virgin spelter; after that came remelted zinc, and lastly, the hard zinc from galvanising works and similar sources. The distillation of zinc was costly in fuel, labour, and materials, but hitherto no really successful substitute for that process had been devised, though much attention had been directed to blast furnaces and electric processes. Professor Turner alluded to the increasing use and diminished cost of aluminium, a metal which, after disappointing many inventors, appeared now to be beginning to take its proper place. Fifty years ago the aluminium prepared by Deville was worth more than its weight in gold. The electric reduction process had displaced all others, and though the business was of the nature of a trade combination the output had increased so that in 1907 nearly 20,000 tons of aluminium was produced, and it could now be purchased at the rate of slightly less than a shilling a pound. The abundance of zinc, and the cheapening of aluminium had gone a long way towards making up for the world's shortage of tin.

——o——

CAPITAL OF T. ALLAN & SONS.—In the Chancery Division of the High Courts, recently, the petition of Thomas Allan & Sons, Limited, of Thornaby-on-Tees, for the sanction of the Court to an extraordinary resolution of the Company to reduce its capital from £60,000 to £50,000, was confirmed. The capital was divided into 30,000 preference shares of £1, and 30,000 ordinary shares at £1. Only 7,500 preference shares were fully paid up. The balance of the preference shares and all the ordinary shares were given in part payment to the vendor to the Company. The vendor, who was respondent to the petition, had agreed voluntarily to surrender 10,000 ordinary shares without any consideration.

CORRESPONDENCE AND QUERIES.

MATCH-BOARDS FOR REPETITION WORK.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Having recently accepted a large order for small repetition castings, the patterns for which we are at present carding, and having had no prior experience with match-boards and oddsides, we should esteem it a favour if you or some of your readers could inform us of the most suitable and durable materials in use for the making of same.

Yours, etc.,
"C. H. & Co."

SAND.

To the Editor of the FOUNDRY TRADE JOURNAL.

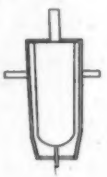
SIR,—If "C. R. T." will apply to Messrs. Bush & Company, sand merchants, Derby, I think they will be able to supply him with a suitable sand.

Yours, etc.,
C. E. ALLEN.

POTS FOR MELTING STEEL.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—In reply to "Clay," the best clay is dark-grey, approaching to black, and when fresh broken, presents a very smooth shining surface. Such as have any tinge or streak of yellow, and break with a dull fracture, contain ochre, and are unfit for the purpose. The clays are generally used mixed; they should be carefully kept clean and dry. When required, one day's make is put into a tub or stone trough and moistened equally, laid upon



the floor, and tempered by treading with the naked feet. This is continued six or seven hours, when that which had at first scarcely any adhesion, becomes a tenacious and ductile mass. The pot-flask or mould, and plug, are usually in the form shown in the illustration. The pot mould is of cast iron, with two ears cast upon it to lift it by. Its inside is the shape of the outside of the pots; it is turned smooth, and is open at the bottom as well as at the top. There is a loose bottom to fit, but not so small as to pass through, which has a hole in the centre three-quarters of an inch in diameter. When in use it stands upon a low post firmly fixed in the ground, which has also a hole five or six inches deep in its centre. The plug, which forms the inside of the pot is of lignum-vitæ, and has an iron centre, which projects through it about five inches, corresponding in size with the hole at the bottom of the mould. The clay for each pot is weighed, and about 24 lbs. is used for each, which is moulded upon a strong bench into a short cylinder. The inside of the mould having been well oiled with whale-oil, the clay is dropped into it, and the plug, also oiled, is forced into the clay, while the projection finds the hole in the loose bottom in the centre of the mould, which guides the plug. The plug is driven down two or three inches by the blows of a heavy mallet on the top of the iron head. It is then taken out to be oiled again, by putting a piece of round iron through the hole in the iron head to lift by, giving it, at the same time, a screwing motion. It is then driven in by the mallet, while the clay, rising up between the plug and the mould, reaches the top. The clay is cut even with the top of the mould, and the plug taken out. The pot is then harrowed at the top by passing a knife round between it and the flask or mould several times, holding it inclined towards its centre. The mould is now taken and set with its loose bottom upon a small post fixed in the floor, and the man gently allows the weight of the mould to rest upon it, which pushes up the bottom with the pot upon it, and the hole being filled with a bit of clay, it is finshed. When the pots are sufficiently hard to bear handling, they are placed to dry upon rows of shelves against the flues in the furnace.

Yours, etc.,
C. E. ALLEN.

SHRINKAGE ON CAST-IRON PIPES.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—Having had trouble with contraction rules myself, I might suggest that "Inquirer" will there find a solution

of his difficulty. I have obtained the following average results from test bars cast at different times, and castings ½ in. in thickness measured up with this shrinkage allowance came about correct to length. My test bars were 12 in. long, ½ in. by ½ in., and gave the following average shrinkage :—Average shrinkage on seven specimens of No. 1 Carron, 0.1444 in.; average shrinkage on eleven specimens, soft mixture, 0.1437 in. These castings were quite soft and turned well. You will notice the shrinkage is much above that allowed for on a contraction rule.

Yours, etc.

W. HUGHES, JUNR.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—"Inquirer" should experience no difficulty in turning out pipes to meet his requirements if he allows one-eighth of an inch per foot for contraction. This being the standard allowance for straight pipes, and takes care not to use iron of too high a character.—C. E. Allen.

MOULDING SAND FOR MEDALLIONS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—We are desirous of obtaining a small quantity of French moulding sand of very fine quality for casting small portrait medallions. Can you inform us where we should be likely to get this sand.

Yours, etc.,

"BRONZE-FOUNDERS."

VERTICALLY CAST PIPES.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—I am producing 9 ft. by 4 in. straight length iron pipes, cast vertically in green sand moulds, wet blacked, and thin dried by coal gas.

The pipes must be sound and clean, having to stand hydraulic test of 500 lbs. to the square inch. They must also be without speck at the turned parts at both ends.

I am troubled, however, with sponginess at the top end. Can you suggest cause and remedy.

Yours, etc.,

"REMEDY."

SILICON.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—We should be obliged if you would kindly put your correspondent "C. P." in communication with us, as we are sellers of ferro-silicon containing from 8 per cent. to 90 per cent. of silicon, and would be pleased to supply him with any particulars he desires in regard to above.

Yours, etc.,

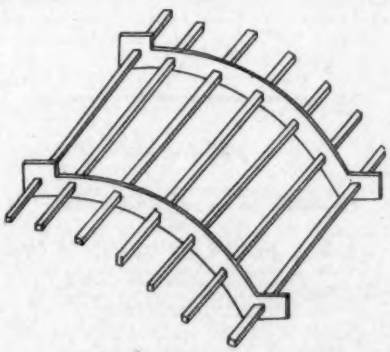
W. C. WILLIS & COMPANY.

90, Mitchell Street, Glasgow.

PROPELLER MOULD.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The sketch of iron for covering propeller blade, which is shown herewith, is, I consider, cheaper than the one shown in Mr. Ashcroft's article; as it is made



wholly of cast iron. The bars shown are made in open-sand, and should be about 1½ in. square. Bricks are wedged in between the bars on a coat of loam. The holes in the side bars should be about 2 in. square, allowing for the insertion of a wedge to tighten up. The straight parts on the side bars are for binding off.

Yours, etc.

"R."

LIST OF NEW INVENTIONS.

Specially compiled for the FOUNDRY TRADE JOURNAL by MR. GEORGE BARKER, Fellow of the Chartered Institute of Patent Agents, Consulting Engineer and Chartered Patent Agents, 77, Colmore Row, BIRMINGHAM.

11,231. F. H. ROGERS. New or improved method of and means for treating moulds for casting metals.

11,421. W. KIRKHAM. Improvements in steel melting furnaces of the crucible type.

12,323. A. J. BOULT. Method of forming ingots.

12,324. A. J. BOULT. Method of making iron and steel.

12,488. F. HERBERT. Improvements in machines for making moulding cores.

12,534. W. MILLER. Improvements in crucible furnaces for melting steel and other metals.

12,613. E. WOODHEAD and E. CLOUGH. New or improved machine for drawing or extracting core wires from brass and other castings, and for analogous purposes.

12,667. B. W. HEAD. Improvements in vertical chargers for charging ingots or the like into furnaces.

28,154. JOSEPH SOUTHALL.

This invention relates to a method of moulding manhole covers and frames, by which the cover and the frame that it fits into, can both be moulded at the same operation in a moulding box of a size in plan sufficient only to just conveniently take the largest of the two parts, which is generally the frame.

FIG 1

FIG 2

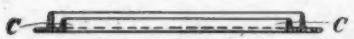
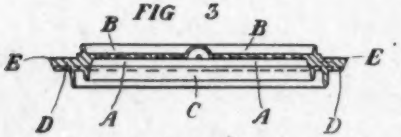


FIG 3



As shown in the drawings, Figure 1 shows a longitudinal section of the manhole cover. Figure 2, a similar section of the frame, and Figure 3, a section of the combined cover frame and core print.

This pattern A is used to form the green sand mould, and it will be seen that it consists of a combined cover B and frame C superimposed and divided by a core print D, the joint of the mould being represented by the dotted line E. E. in Figure 3.

After the pattern A has been drawn from the mould the impression left in the sand by this core print D forms a seat to receive a sand core or chill of the desired section which, when placed in the print impression, will divide that part of the mould which has received the impression of the cover B from that part of the mould which has received the impression of the frame C, so that when the metal is poured into the mould two separate castings, one a cover B, and the other a frame C, are produced.

This method abolishes the need for separate patterns for the frame and cover used, either in separate boxes or side by side in a box of larger area, as the system of using superimposed patterns with a dividing core or chill is conducive to considerable economy of plan space and also in labour needed.

MESSRS. EDMISTON, BROWN & COMPANY, 224, St. Vincent Street, Glasgow, have been appointed agents for the Globe Pneumatic Engineering Company, Limited.

THE Council of the Junior Institution of Engineers announce that through the munificence of Mrs. F. R. Durham, a bursary of the value of £25 per annum, to be called after the Chairman of the Institution, the Durham Bursary, is about to be offered to the members and associates, of whom those between the age of 20 and 22 will be eligible to compete by writing a thesis on some technical subject chosen by the candidate. The first award will be made in October.

MESSRS. R. WOLF, engineers and boilermakers, of Buckau and Norfolk House, 7, Lawrence Pountney Hill, Cannon Street, London, E.C., notify us that a test by Professor M. F. Gutermuth, of the Chair of Engineering, Darmstadt, of their new 100-b.h.p. patent superheated steam locomobile or semi-portable engine, fitted with Wolf's balanced piston valve gear, gave a consumption of 1,045 lbs. of coal per b.h.p. per hour, and 8,661 lbs. of steam per b.h.p. per hour. It is claimed that this result establishes a new world's record.

TRADE TALK.

MESSRS. KRUPKA & JACOBY have removed to 11, Queen Victoria Street, London, E.C.

MESSRS. DORMAN & SMITH have removed their London offices to 17, Victoria Street, Westminster, S.W.

MESSRS. L. CROOKE and T. W. WILKINSON, general engineering contractors, Middlesbrough, have dissolved partnership.

A DISSOLUTION of partnership is notified in connection with Messrs. F. Broadbent and W. Dex, boiler coverers, Oldham.

MESSRS. BRAMWELL & HARRIS, consulting engineers, have removed to 11, Great George Street, Westminster, London, S.W.

THE directors of Gourlay Brothers & Company, Limited, shipbuilders and engineers, Dundee, propose reconstructing their concern.

IN order to deal with a further increase of business, the directors of the Lincoln Wagon and Engine Company have issued 5,000 shares of £20 each.

MESSRS. J. DICKINSON & COMPANY, Devonshire works, Keighley, have disposed of their business to Messrs. S. Lund & Sons, Keighley.

THE BRITISH GENERAL ELECTRICAL COMPANY, 17, Hatton Garden, London, E.C., has changed its style to the British Central Electrical Company.

A RECEIVING order has been made in connection with the affairs of Messrs. Wm. Reid & Company, machine tool makers, Fenchurch Street, London, E.C.

THOMAS PARKER, LIMITED, electrical engineers, of Wednesfield Road, Wolverhampton, are extending their business to the manufacture of the "Roturbo" pump.

MESSRS. E. H. KELLOG & COMPANY, of New York, Liverpool, and London, have appointed as agents in Glasgow Messrs. Westwood, Macneil & Company, 72, Waterloo Street.

MESSRS. L. E. WILSON & COMPANY, of Manchester, have established a branch at New York Buildings, 67, Stanley Street, Liverpool, with Mr. F. L. Monkhouse in charge.

MESSRS. KNOWLES & WOLLASTON, 26, Victoria Street, Westminster, S.W., have taken over the European business of the Joseph Dixon Crucible Company, of Jersey City, U.S.A.

MESSRS. BROWN, BOVERI, & COMPANY have concluded an arrangement with the German Admiralty whereby the latter acquires the right to build marine steam turbines on the company's system.

MESSRS. MUSGRAVE & SONS, of the Globe Iron Works, Bolton, are just completing an equipment of turbines of the "Zoelly" type in the Falcon Spring Company's new mill at Bolton.

MESSRS D. ROWAN & COMPANY, marine engineers and boilermakers, 231, Elliot Street, Glasgow, have assumed Messrs. J. G. Young, W. Todd, and W. Weir as partners in their business.

MESSRS. C. A. PARSONS & COMPANY, Heaton Works, Newcastle-on-Tyne, have removed their Leeds office from 13, Peacock's Buildings, Park Row, to 65-67, Prudential Buildings, Park Row, Leeds.

WILLANS & ROBINSON, LIMITED, have decided to discontinue their Ferry Works, Queen's Ferry, near Chester, and confine their operations to Rugby. The works will be offered for sale by public auction very shortly.

THE business of the Jones-Westwood Electrical Manufacturing Company, of Leeds, has been taken over as a going concern by Mr. Conrad Ingleby, whose intention it is to carry it on under the name of Ingleby & Company.

MR. P. D. TONIDES, Scottish manager of the British Westinghouse Electric and Manufacturing Company, Limited, is resigning that position in the autumn in order to join Mr. W. L. Spence, consulting engineer, 31, St. Vincent Place, Glasgow. The business will be carried on under the style of Spence & Tonides.

THE membership of the Glasgow Chamber of Commerce has been largely extended of late, and now embraces the Scotstoun Iron Works; Marriott & Graham, Plantation Boiler Works; Mavor & Coulson, Limited; Wm. Simons & Company, Limited, Renfrew; and L. Sterne & Company, Limited, Crown Iron Works.

THE annual meeting of the Machinery Users' Association was held recently, in London, Sir W. H. Holland, M.P., the president, occupying the chair. The chairman, in moving the adoption of the report, said that in the last 12 months 135 cases of over-assessment had been dealt with, as compared with 100 the year before. In the great majority of these cases complete satisfaction had been expressed by members about the results achieved.

PERSONAL.

THE gross value of the estate of the late Mr. B. H. Thwaite is £1,076.

LORD ARMSTRONG has resigned his directorship of the North-Eastern Railway Company.

THE late Mr. G. Pollard, of Messrs. Chas. Booth & Company, engineers, left estate valued at £39,461 gross.

COLONEL WATSON, a director of Messrs. J. & J. Savile & Company, steel manufacturers, Sheffield, has resigned.

MR. JAMES GRIFFITHS has been appointed manager of Messrs. Cammell, Laird & Company's Derwent Works, Workington.

THE late Mr. C. H. Woodhouse, of the Manor House, Hexthorpe, brass and iron founder, left property valued at £37,047.

THE late Mr. M. H. Larmuth, of Messrs. T. Larmuth & Company, Todleben Iron Works, Salford, left estate valued at £15,694.

THE late Colonel H. F. Swan, C.B., a director of Armstrong, Whitworth & Company, left estate of the gross value of £558,287.

MR. S. MASTERSON has been elected general secretary of the National Union of Ironfounders, in succession to Mr. J. Maddison.

MR. J. M. KENNEDY and MR. S. BRYAN DONKIN have been admitted into partnership with Messrs. Kennedy & Jenkin, of 17, Victoria Street, Westminster, London, S.W.

MR. H. R. CHAPMAN, chairman of Clarke, Chapman & Company, Limited, has resigned in consequence of ill-health, and has been succeeded by Mr. H. Walker.

MR. F. WALKER, cashier of Messrs. James Oakes & Company's Alfreton Iron Works, has been the recipient of a presentation from the staff on the occasion of his marriage.

MR. M. BLAIR has resigned his position as general manager of Messrs. Francis Morton & Company, Limited, bridge and roof builders, ironfounders, and engineers, Garston, Liverpool.

PROPERTY amounting to £63,150 19s. 10d., has been left by the late Mr. P. F. Hoole, chairman of H. E. Hoole & Company, Limited, stove-grate manufacturers, Sheffield.

MR. J. D. R. PHILLIPS, of the Great Northern Railway Company's locomotive and wagon works, Doncaster, has been appointed general manager of the Yorkshire Engine Company, Limited.

MR. W. H. HAWTHORNE, one of the directors of the Cannon Iron Foundries, Limited, of Deepfields, has been the recipient of a presentation from the officials and men in connection with the commemoration of his silver wedding.

MR. J. J. HILL has been appointed a director of John Priest & Son, Limited, Bristol, in place of the late Mr. A. Petter. Mr. Hill is the West of England representative of John Lysaght, Limited, and he has acted as secretary for J. Priest & Son, Limited, for many years past.

THE Committee appointed by the British Iron Trade Association to take charge of the fund for the presentation to Mr. J. S. Jeans, formerly secretary of the Association, announce that a very satisfactory response has already been made to their invitation. It has been suggested that the testimonial should take the form of a piece of plate, accompanied by an illuminated address from the subscribers, and that the presentation should be made an official one. The subscription list closes on July 15.

MR. R. BUCHANAN, of Birmingham, has been awarded by the Council of the Royal Society of Arts, the silver medal of the Society for his paper on "The Application of Science to Foundry Work," read at a meeting of the Society on February 12 last. The presentation will be made at the opening meeting of the Society in November next. Mr. Buchanan was the first President of the British Foundrymen's Association, and at present is the President of the Birmingham Branch, having also held the position of President of the South Staffordshire Iron and Steel Institute, and other important offices.

A VERY interesting account of the career of Mr. Alfred Featherstone, of C. & W. Walker, Limited, of the Midland Iron Works, Donnington, is contained in a recent issue of the "Birmingham Gazette and Express." The great iron works owe their expansion largely to the unsparing efforts of Mr. Featherstone. He was early associated with the founders of that business, and has for thirty-five years been actively interested in the development of the industry carried on at the Midland Iron Works. When in 1899 the business was sold to a limited company the invaluable services which he rendered were fittingly acknowledged by his appointment to the post of managing director. He continued in control until two years ago, when he resigned the office, but retained his seat on the directorate, and now he acts in an advisory capacity to the present management.

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BLACKFRIARS, MANCHESTER.

NEW COMPANIES.

THE KIRKSTALL FORGE COMPANY, LIMITED. — Capital £150,000, in £1 shares.

SPANISH PARSONS MARINE TURBINE COMPANY, LIMITED.—Capital £5,000, in £1 shares.

BUFFALO FORGE COMPANY, LIMITED.—Capital £5,000, to carry on the business of ironfounders.

HEAD, WRIGHTSON & COMPANY (SOUTH AFRICA), LIMITED.—Capital £50,000, to carry on the business of engineers, etc.

SMITH & SONS' WAGON COMPANY, LIMITED.—Capital £1,000, to acquire the business carried on by G. H. Smith, at Inkerman Street, Wolverhampton.

TAIKOO DOCKYARD AND ENGINEERING COMPANY OF HONG KONG, LIMITED.—Capital £80,000 in £100 shares. Registered office: 8, Billiter Square, E.C.

JOHN SPENCER & COMPANY (KEIGHLEY), LIMITED.—Capital £8,000, to take over the business of a machine tool maker carried on by Mr. J. Spencer, Atlas Works, Keighley.

HENRY BLANCHARD, LIMITED.—Capital £5,000, to take over the business of an engineer, etc., carried on by Henry Blanchard at Campbell's Jetty, the Humber Bank, Grimsby.

PUMPS, LIMITED.—Capital £10,000, to acquire from J. L. Hanman certain patents for inventions relating to engines and pumps. Registered offices: 20, Ethel Street, Birmingham.

GOUGH, SPITTLE & COMPANY, LIMITED, —Capital £1,000, to carry on the business of fender, fire-iron, grate etc., manufacturers, etc. Registered office: Churchfield Street, Dudley, Worcs.

W. FORREST & COMPANY (SHEFFIELD), LIMITED.—Capital £2,000, to take over the business of electrical, mechanical, and general engineers, carried on by W. E. Forrest at Industry Works, Sylvester Gardens, Sheffield.

E. LLOYD & COMPANY, LIMITED.—Capital £15,000, to take over the business of metal knob, rail knob, and metal ball manufacturers, carried on by E. H. Lloyd and T. J. Wigley Allen, at the Metal Ball Works, Camden Street, Birmingham.

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DEATHS.

MR. JAMES BARR, senior partner of John McDowall & Sons, engineers, Johnstone.

MR. J. MCCULLOCH, manager of the St. Rollox Works, Glasgow, at the age of 69 years.

MR. JOSEPH BERRY, proprietor of the Albion Foundry, Swinton, near Manchester.

MR. T. GIBBINS, a director of the Birmingham Battery and Metal Company, Limited.

MR. FREDERICK WARD, formerly chairman of the Sheffield Forge and Rolling Mills, Limited.

MR. W. T. FLATHER, head of the firm of W. T. Flather, Limited, Standard Steel Works, Sheffield.

MR. W. T. LITHGOW, of the shipbuilding firm of Messrs. Russell & Company, Kingston, Port-Glasgow.

MR. W. ROBINS, of Wynn, Timmins & Company, Limited, tool manufacturers, Birmingham, aged 82 years.

MR. THOMAS BEELEY, J.P., of the firm of Messrs. Thomas Beeley & Son, Hyde Junction Boiler Works, Cheshire.

MR. H. T. DAWES, a well-known figure in Sheffield engineering circles, having been for about fourteen years mill manager at the works of Messrs. W. Gallimore & Sons.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

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As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

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PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

Metals.	1907-8.	1906-7.
Iron—Scotch pig warrants ... ton	..... *56 3	..... *65/0
—Middlesbro' warrants ... ... ton	..... 51 0	..... 56/9
—W.C. M/nos Bessemer ... ... ton	..... 60 6	..... 81/6
—Stock, Scotch, June 30 ... tons	 1,000	 2,200
Copper—Chili bars, GMB ... ... ton	..... £57 12/6	..... £99 17/6
—Stock, Europe & afloat... ... tons	 37,711	 11,181
Tin—English ingots ton	.....£127 0/0	..... £195 10/0
—Straits ... ton	..... £125 15/0	..... £191 15/0
—Stock, Ldn. Hind and afloat ... tons	 14,705	 11,612
Lead—English pig ton	..... £13/0 0	.... £20 15/0
Spelter—Ord. Silesian ... ... ton	..... £18 17/6	..... £24 10/0
Quicksilver—(75lb.) bottle	£7 17/6–£8 0/0	...£6 16/0–£7 0/0
Antimony—Regulus ... ... ton	..... £34 0/0	...£53 0/0–£55 0/0

*Settlement price.

Castings.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 15 0	to	7 0 0
Pipes, 1½ to 2½ in.	5 2 6	to	5 7 6
„ 3 to 4 in.	4 15 0	to	5 5 0
„ 5 to 8 in.	4 12 6	to	4 15 0
„ 10 to 16 in.	4 12 6	to	4 15 0
„ 18 to 24 in....	4 12 6	to	4 15 0
Chairs	3 10 0	to	3 15 0
Floor plates (open sand)	3 2 6	to	3 5 0

Scrap.

The quotations for scrap, subject to market fluctuations, are as follows:—Heavy wrought (mixed), £2 7s. 0d.; light wrought, £1 1s. 0d.; heavy cast, £2 6s. 0d.; all per ton f.o.b., London. Copper (clean), £54 0s. 0d.; brass (clean), £40 10s. 0d.; lead (usual draft), £12 0s. 0d.; tea lead, £10 5s. 0d.; zinc, £15 0s. 0d.; all per ton delivered merchant's yard.

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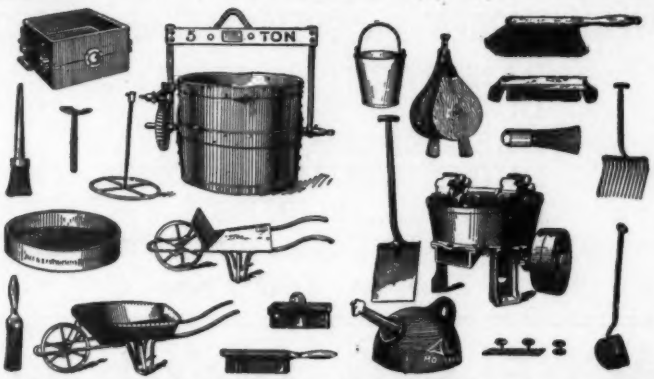

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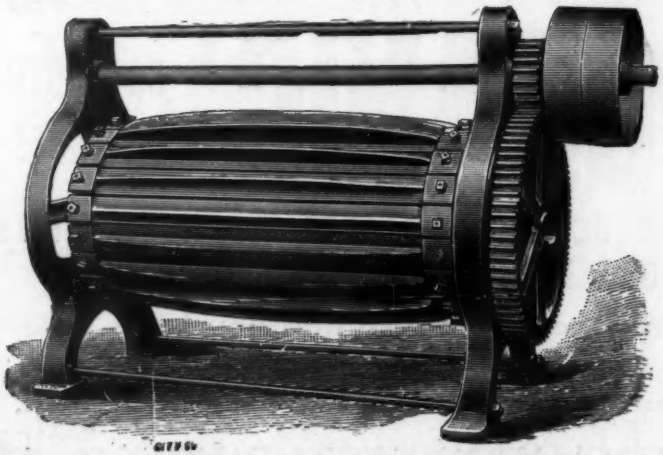

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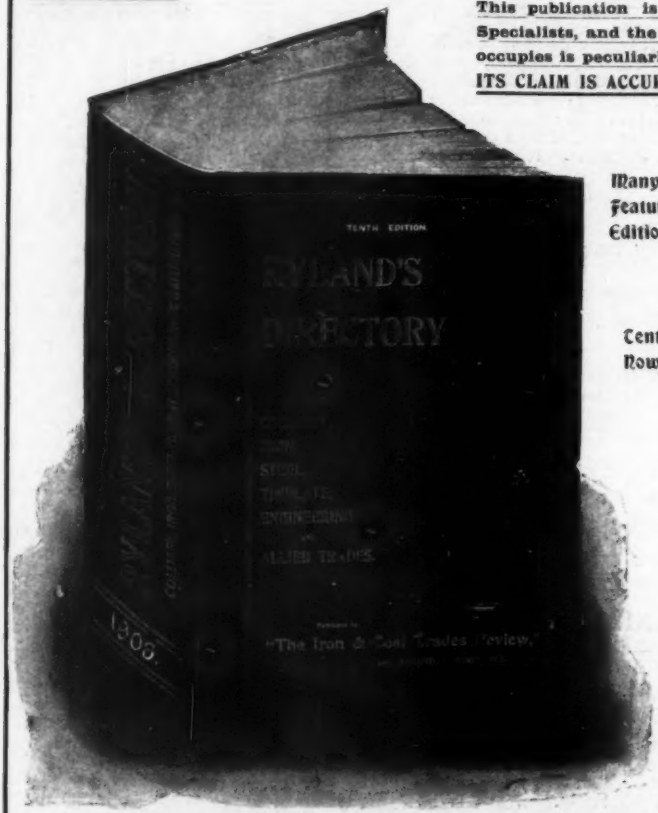

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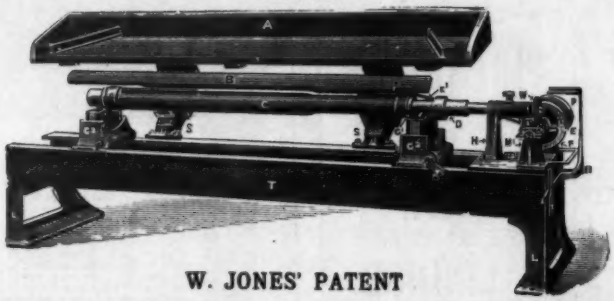

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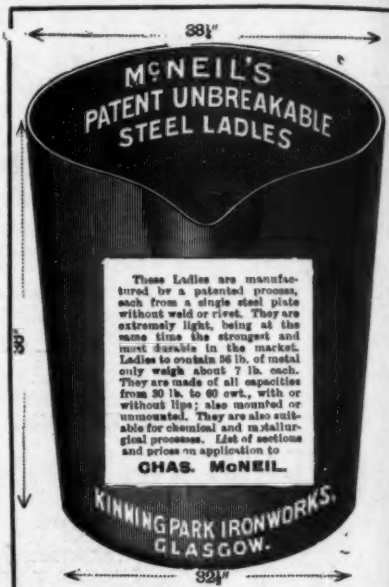
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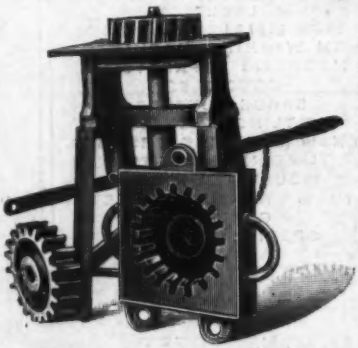

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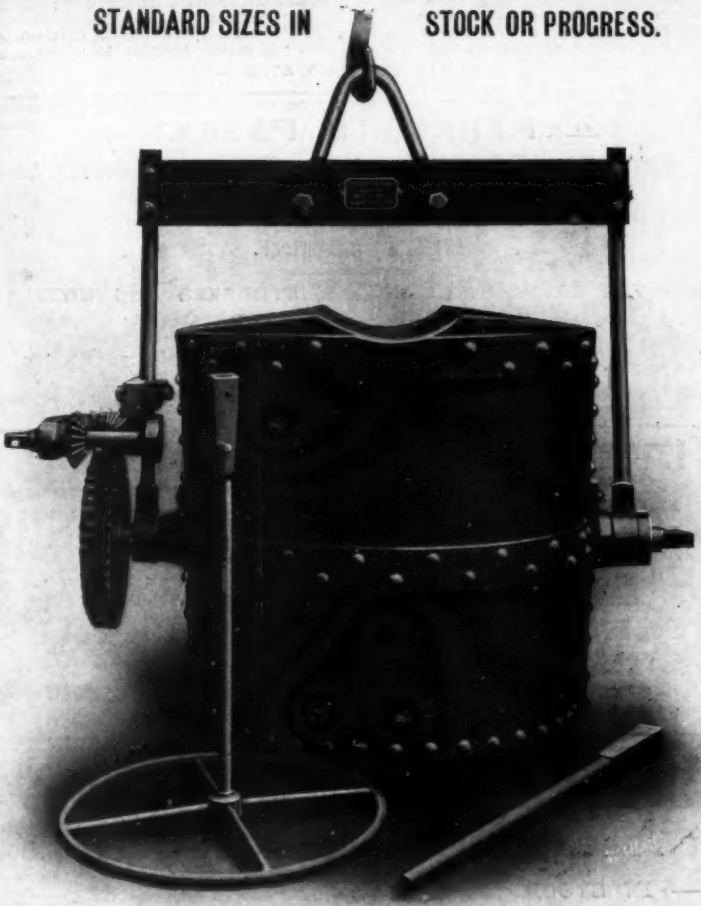

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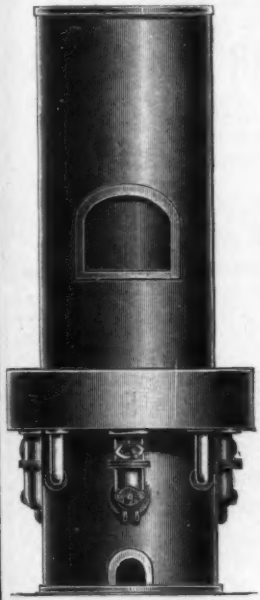

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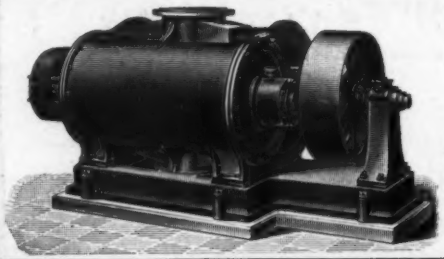

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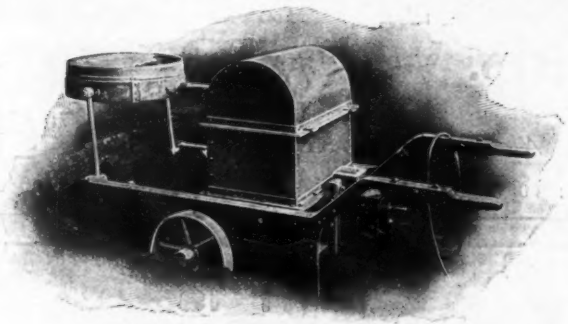

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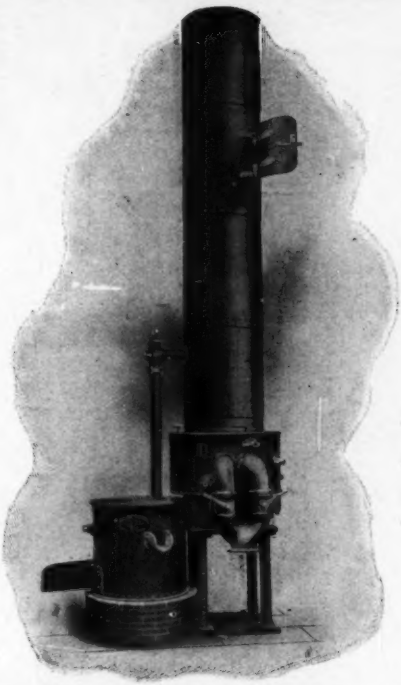

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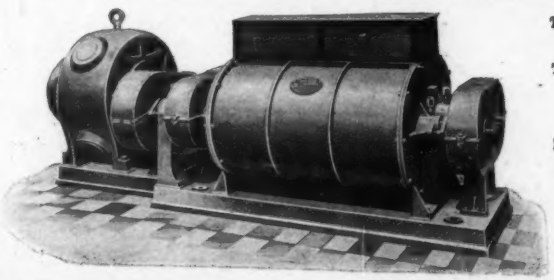

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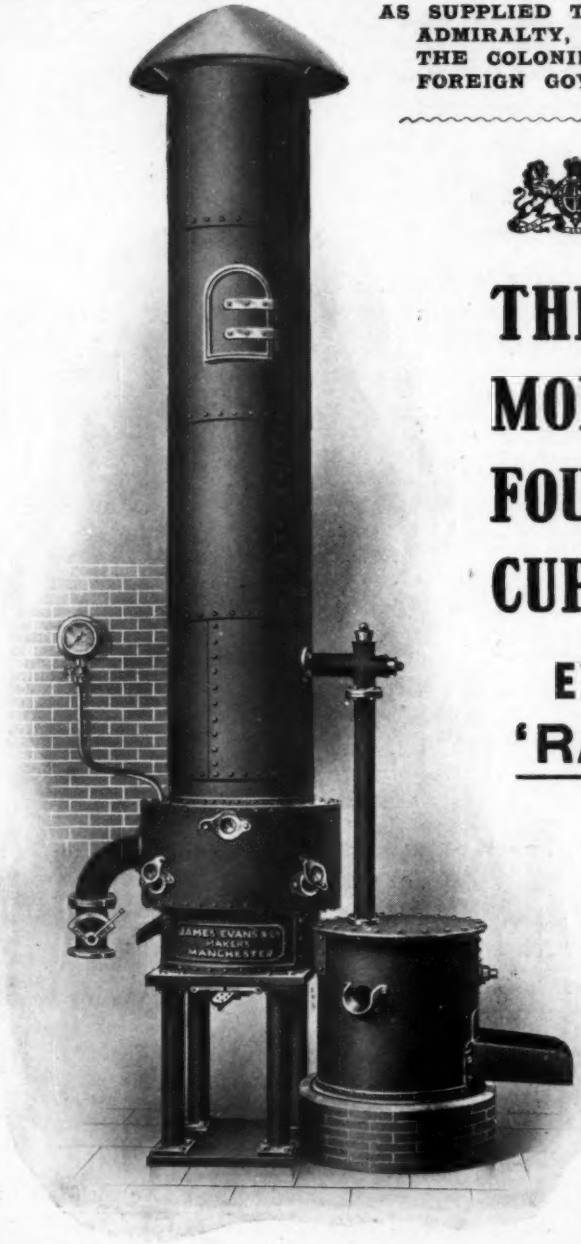

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